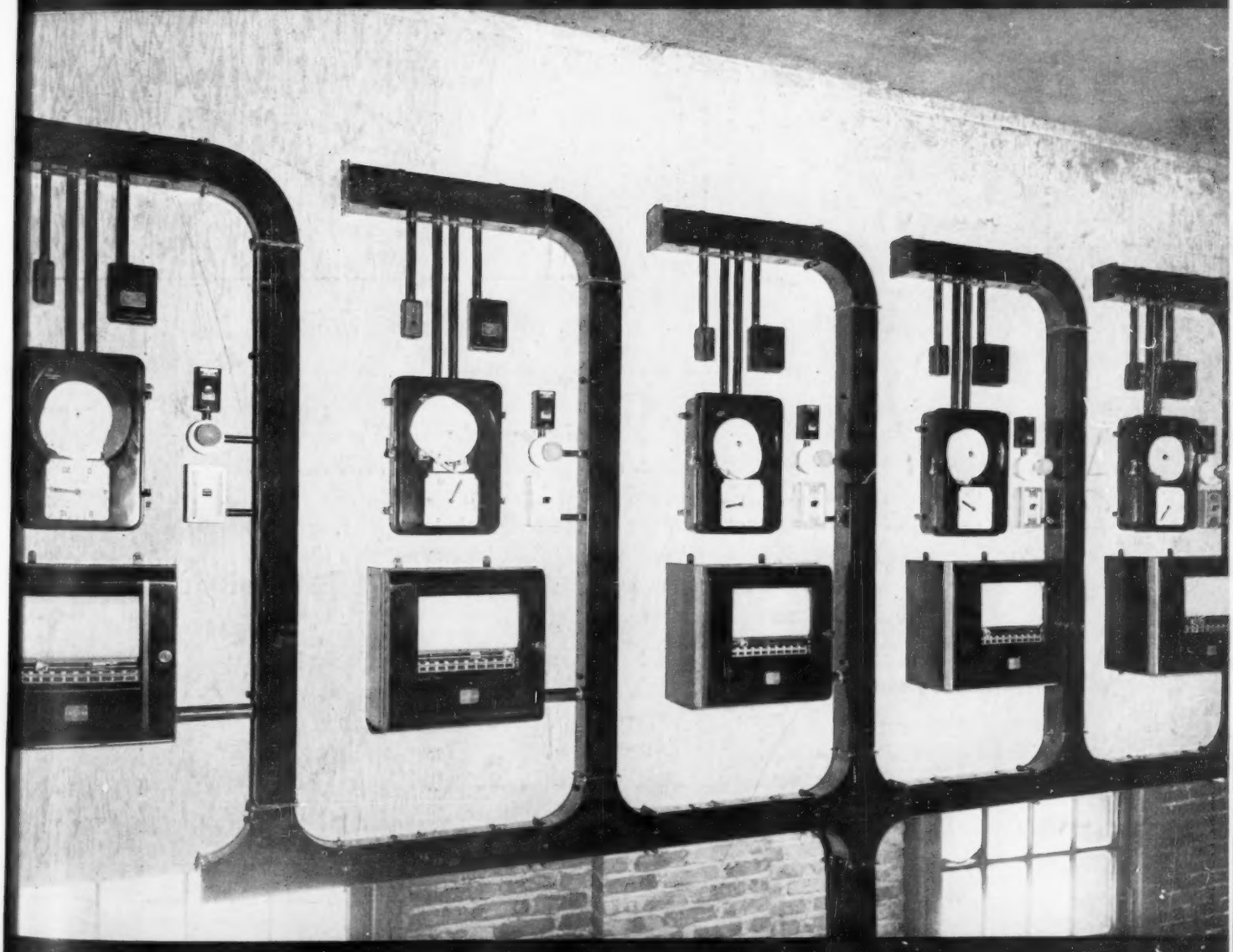
Instruments

THE MAGAZINE OF

Measurement and Control

Vol. 15
DEC. 1942
No. 12



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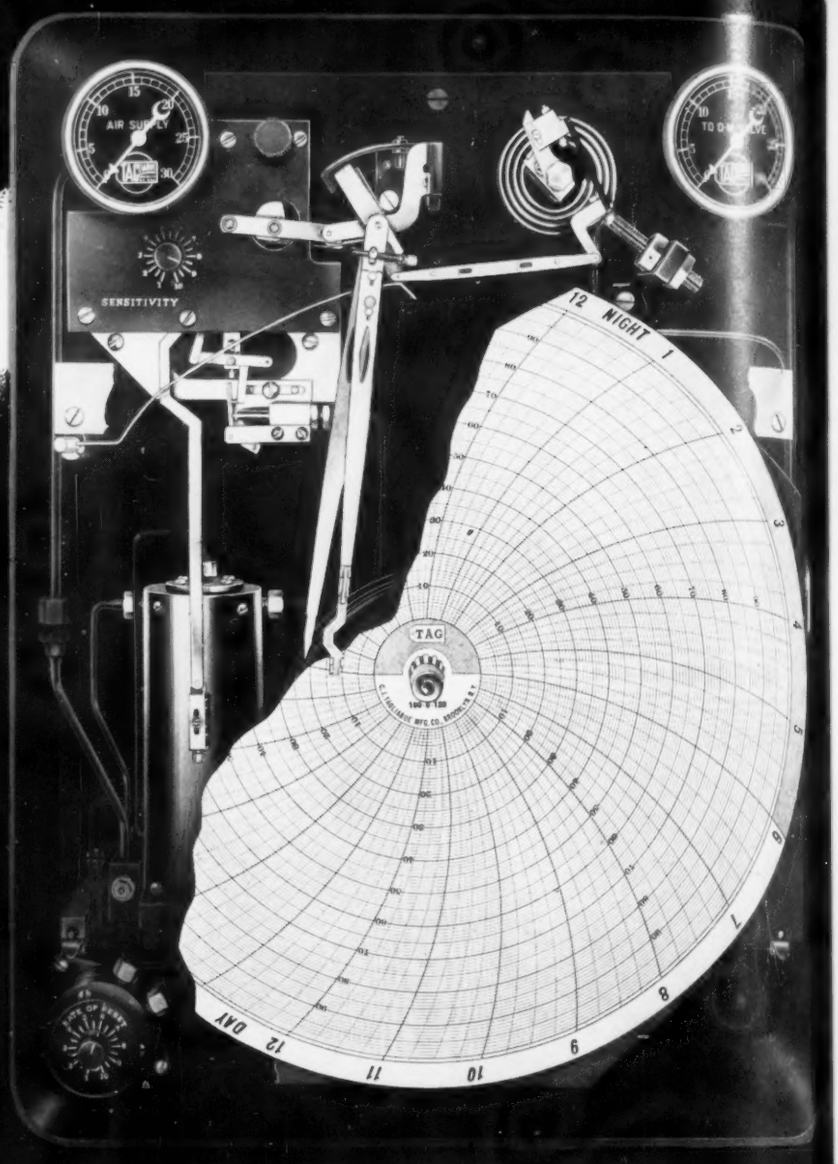

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Thousands of TAG Recording and Controlling Instruments are in effective service today in the synthetic rubber, chemical, catalytic cracking, aeroplane engine testing, ordnance and food fields. At this time, when uninterrupted production is vital and needless re-runs set back the war effort, you particularly need the well demonstrated control efficiency that TAG offers.

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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Long Wars Create Short Tempers

TODAY is December 7th, first anniversary of "a day that will live in infamy" as our Commander-in-chief prophetically declared. The last few days, editors and commentators (and even some newspaper and magazine ads) have been remembering Pearl Harbor so rhetorically that I tore up the "masterpiece" I had been polishing up for this page. . . . You're welcome!

There are several things which all of us can do, not merely as citizens of our beloved country but *as instrument men*. Some of these things are obvious (for example, extending the use of automatic instruments to speed up war production); other things are not so obvious. Here is one:

As the burdens of war begin to hurt, many of us tend to become somewhat irritable. Therefore I ask you to read (and *heed*) a portion of the first editorial I wrote on being appointed editor in June 1933:

> . . . To be sure, the millenium has not arrived. . . . Sales engineers . . . still number in their midst a few "promise-anything-to-get-the-order" sinners. Manufacturers still print a few exaggerations. And some users still display cynicism and intolerance toward the most ethical of those who try to serve them . . . Get together! Ask and answer all relevant questions! . . . Above all, don't nurse grudges. If you think you have a grievance, get it off your chest. . . .
>
> **We are all colleagues in one esteemed profession: All men who invent, design, build, sell, specify, apply, install, service and maintain measuring instruments, gages, meters and automatic control equipment belong to one fraternity. . .**

Some "pet peeves" will only vanish when brought out into the light. Therefore suppliers and users are hereby invited to present their "cases" in the columns of *Instruments*. This invitation applies not only to mutual or reciprocal grievances; it applies to kicks against third parties outside the field of instrumentation; it applies to protests against circumstances. I am convinced that these difficulties were not deliberately created by men but arose from *new situations*—new relations, new ways of transacting business and installing products.

Anyway, get it off your chest! Write it up carefully, just as a lawyer presents his "case." Beginning in our February issue, and for the duration, this type of article (hitherto rejected) will be accepted. I believe this new policy will do much to end "pet peeves." As I wrote on this page one year ago, just after Pearl Harbor, "Every good American is a Boy Scout at heart . . . Of all good Americans none is better than the measurement-minded, the one with a keen sense of true values—*you!*"

—MFB

The Counter Reads 00180

and thereby registers the end of the fifteenth year of *Instruments'* service to users of measurement and control devices—service to the

UNITED STATES OF AMERICA

The entire staff of *Instruments* wishes you

A Merry Christmas and a Happy New Year

On Joining the Armed Forces

IN answer to requests from subscribers for information on opportunities for doing instrument work in the Army and Navy, last month's editorial was devoted to that subject and to the needs of industry. Its title was "General Man-power Needs; Individual Decisions." It summarized a number of points and quoted Army and Navy releases. It ran to more than two pages—the longest we ever printed. Now, as this issue goes to press, news comes of

(1) An Executive Order giving the War Man-power Commission, "sweeping power over the country's man-power, including control over the operations of the Selective Service system and the moving of workers in non-war industries into war industries."

(2) Suspension of induction of "all" men 38 or older.

(3) Stoppage of "all" voluntary enlistments of men between 18 and 38.

(4) Training of workers for vital war industries placed under War Man-power Commission.

(5) Enlargement of powers of United States Employment Service.

These are the high lights. By the time you receive this copy of *Instruments*, the broad Executive Order will have begun to be translated into numerous specific Army and Navy orders and statements, civilian-agency regulations and statements, etc. We feel safe in predicting that *there will be exceptions*—particularly affecting highly-skilled men, professional engineers, physicists and chemists, experienced production men, experienced teachers, industrial executives and various other classes of *Instruments* subscribers. Watch the newspapers carefully during the next month or so and bear in mind that the American government is the best on earth, so that if you have been considering making a change for the *mutual benefit* of the War Effort and of yourself, your government will not "freeze" you but will help you. For example we have just 'phoned to a local Army office and have been assured that "skilled men not otherwise available" are still wanted even if they are over 38, although, of course, the Army will strive to obtain such men from "other than essential war industries or occupations." The point is that America is American and Americans are America. When you read the papers, disregard the sour-puss commentators who will try to find fault.

Put Idle Instruments to Work

UNDER this heading we published in recent issues the plans of the Instruments Publishing Company and of others. If you have idle instruments, or if you cannot obtain the instruments you want, look up page 396 of the October issue and write to the Available Instruments Department as directed. In this connection, Mr. Rimbach, who has charge of that Department, has asked us to thank on this page the many "haves" and "wants" who have taken advantage of the IPC plan: a large percentage of "haves" and "wants" got together. That's the American spirit!

The Pitfalls of Temperature Measurement*

By C. O. FAIRCHILD

Director of Research, C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.

Introduction

THE very nature of temperature, which is a unique physical concept, is such that it is difficult to clearly define and measure. Our initial more or less vague ideas about temperature spring from our sensations of heat and cold. If we touch an object which feels warm this sensation resulted from the flow of heat to our finger. We haven't time to discuss the physiology of this sensation but must direct our attention to the fact that temperatures are not sensed by any other means than by an observation of a flow of heat. Maxwell defined the temperature of a body as its thermal state considered with reference to its ability to communicate heat to other bodies. It follows then, that in order to measure the temperature of a body we must determine its ability to communicate heat to another body. This means that we must control and observe heat transfer, and we are in immediate difficulty, because heat has a disconcerting characteristic of flowing through everything, and at rates which vary over wide limits. For example, if we touch a piece of metal at 120°F., heat flows very rapidly to our finger and we conclude the metal is very hot. On the other hand if our fingers are only a little protected by callous we can pick up and hold glass at 200°F. because of the poorer conductivity of the material. We can expect, then, to find pitfalls in the practical matter of handling heat flow—one source of trouble.

In order to specify temperatures, numbers have been arbitrarily assigned to critical thermal states such as melting and boiling points of various substances; for example 0°C. for the melting point of ice and 100°C. for the boiling point of water. The variation of numerous physical properties of substances have been experimentally observed so that they can be used for measuring temperatures between these critical points. Hence we must become familiar with the thermometric properties of various substances—a second source of trouble.

If we peruse the first 23 pages of the A.I.P. Temperature Symposium,† where Wensel fully describes our concept of temperature** and how it is measured, we learn that the physical laws with which we must become familiar in order to understand what we are doing when we attempt to measure temperature, are complex and difficult to handle. They are a third source of pitfalls.

Briefly, we conclude that our success in avoiding pitfalls will be commensurate with our knowledge and experience, and their painstaking and attentive application to problems in hand. When we observe or measure a temperature we note the coincidence of some pointer on a scale. We must think beyond this simple observation, and not be satisfied as we are when we lay a rule between two points, or adjust weights on a balance, and then watch for the required coincidence. Suppose that we are about to use a clinical thermometer. We must be sure that the patient has not had a drink during the previous half hour. We must shake down the mercury in the capillary column. Next we place the thermometer bulb carefully under the tongue where it will be nearest circulating blood. Then we wait—for thermal equilibrium to be established. Having assured ourselves that the thermometer was colder than the patient's mouth before we inserted it, we can now remove it, because it is designed to register a maximum, before we note the coincidence. We will have measured a temperature successfully, provided that we have had the faithful coöperation of the patient. One medical authority states that there are seven or eight ways for the patient to deceive the doctor who is taking his temperature. We will not dwell on these, but emphasize the point that the mere observation of the coincidence on a scale is likely to be all too disarming, and lead one to thoughtlessly act as though he had measured a temperature.

Conditions to be Met

The things whose temperature we have to measure from time to time are so varied in form and condition that we can only touch upon the principal sources of difficulty. One is temperature gradient or lack of uniformity of temperature. At ordinary temperatures this imposes the added difficulty of obtaining sufficient immersion of a thermometer or thermocouple. The well-known test for sufficient immersion (provided that there is a space at *uniform* temperature) is to observe that the immersion selected is enough that a little less gives the same reading. This test fails completely in the presence of gradients and we find it necessary to use our wits to the utmost on this apparently simple problem. We may find that an awkward series of experiments are necessary to provide even an approximate answer. We should preferably turn our attention to noting the direction of flow of heat and the possibility that the thermometer can be inserted at right angles to this direction, that is, in a nearly isothermal layer. This will tend to overcome the unavoidable circumstance that, as in most cases, heat is flowing along the thermometer, and if the temperature is above that of the surroundings, this heat is to be supplied from the oven or bath or whatever we are measuring. This kind of so-called lag in a thermometer is very often a difficult characteristic to combat. Every means should be used to promote thermal contact and low resistance to heat-flow between the thermometer and the object. If the object is a solid, we are principally concerned with whether or not it is a good conductor of heat. If it is a liquid, we must see that it is flowing past the thermometer with sufficient velocity. For example, the thermometer should not be immersed in any region where the liquid is stagnant.

Before touching on the subject of temperatures of gases we shall mention the other important condition, that of inconstancy or variation of temperature with time. Here we are concerned also with the promptness of response of the thermometer, that is, its time lag. Experience in the art is especially important in finding the right answer to the problems which arise from these circumstances. It is necessary that the observer use plenty of time in his observations (e.g. 1 hr. if a hunting period is 15 min.) before drawing conclusions regarding the effects on the accuracy of measurement, particularly where large masses may be varying slowly in temperature.

As higher and higher temperatures are met, radiation becomes more important in comparison with convection. If the temperatures are high enough to be measured with a radiation or optical pyrometer then we are principally concerned with the lack of blackbody conditions consistent with the presence of gradients. With these pyrometers true temperatures are indicated only where blackbody conditions are found. If the temperature within an enclosure is not uniform, then when the pyrometer is sighted at the hottest zone the temperature indicated is below the true temperature and when sighted at colder spots the temperature indicated is higher than the true temperature. Sometimes it is possible to avoid this difficulty with the optical pyrometer by sighting it at a small hole in the inner wall of a furnace. The large source required for radiation pyrometers does not permit this. In case temperatures are varying they can be followed rather rapidly with either of these pyrometers and if careful attention is paid to the times at which readings are made, then proper conclusions may be drawn. We have not in mind the radiation pyrometer which is sighted into a closed tube built onto it: this instrument has more

*Presented before the New York Society for Measurement and Control October 27, 1942.

†Published by Reinhold Publ. Corp., N. Y., 1941; reviewed in *Instruments*, Feb. 1941.

**See also Worthing's paper on the temperature concept in the same book, page 41.

nearly the characteristics of a thermocouple so far as discussion at this point is concerned. In the use of the open radiation pyrometer we must look out for the presence of smoke or of carbon dioxide and water vapor. These gases are relatively opaque to infrared radiation and their presence results in low readings. It is particularly important to remember that the interior of a hot furnace does not appear the same to a radiation pyrometer as it does to the eye. If our eye had a similar sensitivity to that of the pyrometer, carbon dioxide and water vapor within a furnace would appear as dense clouds.

The measurements of hot gases present extraordinary difficulties if they are confined by walls which are at a different temperature, for example in the case of hot gases in boiler chambers or flues. To solve this problem in the more difficult cases there has been developed the so-called high-velocity thermocouple described by Mullikin in the Temperature Symposium. The solution lies principally in that the gases pass the thermocouple rapidly and that the walls visible to the thermocouple are very nearly as hot as the gases. This last is accomplished by double shielding of the thermocouple. Many arrangements for this problem are described by Mullikin.

Test Methods

Those who are interested in the problems of measuring temperatures find it necessary to learn methods of testing thermometers and pyrometers with some degree of precision and accuracy. We should like to present the point of view that the first requirement in a testing laboratory is up-to-date and adequate information such as values of the fixed points on the temperature scale, tables for thermocouples and resistance thermometers, standard methods of testing, etc.

So far as the technique of methods is concerned the primary requirements are temperature uniformity and constancy of baths and furnaces and always close similarity of the standard instrument and the one to be checked. If they are different, errors of comparison are almost completely unavoidable. These errors of course will be augmented by inadequate stirring of a bath for example, or temperature gradients in a furnace.

Of all the test points available the greatest reliance should be placed on the ice point. Ordinary clean ice broken into small pieces and wet will reproduce this fixed point very accurately. Only a few industrial laboratories are provided with equipment for testing at other fixed points and we should like to warn against the use of boiling points of liquids except for obtaining a constant temperature for comparing two or more thermometers. The steam point for example, is not reproducible without an excellent hypsometer and a very expensive barometer with all the cumbersome tables for correcting the barometric reading for temperature, latitude and altitude. Most laboratories are supplied with standard specially-calibrated instruments for test purposes.

If it is necessary to compare a mercury thermometer with a resistance thermometer the bulbs should be as near each other as possible in a well-stirred bath. If the resistance thermometer requires an immersion of say 10″, and the permissible immersion of the thermometer is only 6″, then we can expect errors of measurement. If it is necessary to test partial-immersion thermometers it is preferable to have a whole set of standard thermometers of the same kind and dimensions so that the immersions can be identical during the test.

Thermocouples are compared by welding their hot junctions together and if this cannot be done the junctions should be put inside a metal block having a small hole drilled in it. While mercury thermometers and resistance thermometers which are off calibration have to be tagged with corrections, thermocouples can often be restored to their original calibrations or very near them. In the case of base-metal thermocouples of 22 gage and larger, it sometimes suffices to remove the outer oxide. Personal instruction or teaching is required for learning how to restore rare-metal thermocouples.

In testing electrical thermometers special care should be exercised in the connection of copper leads and extension leads and in the polarity of reference junction connections. Laboratory potentiometers *without* automatic reference junction compensation should be at hand. Depending on the degree of accuracy aimed at, a special Wheatstone bridge for resistance thermometers may be acquired. Precise resistance thermometry requires the use of four-lead thermemeters and if only three-lead thermometers are used they should be tested by comparison with standard high grade mercury-in-glass thermometers.

Characteristics of Mercury Thermometers

The so-called emergent stem error is our first stumbling block. We should know first how to correct for this. Be sure that we know what kind of glass and the data applicable to it. There are only two common ones used, one is a lead glass with a small coefficient of expansion for use up to a little over 750°F. and the other is a borosilicate glass with a relatively large coefficient. These corrections are best applied to so-called total-immersion etched-stem thermometers. Etched-stem thermometers marked for use at partial immersion should always be used immersed to the mark and not at some other value to be corrected for.

The mercury-in-glass thermometer properly used can provide very accurate measurements in spite of the fact that glass is not a stable substance. Due to this natural instability high accuracy is obtained only by the use of repeated checks at the ice point. This means of course that a mercury thermometer on which we depend for high accuracy must have the ice-point engraved on it for check purposes. If it is heated to the upper part of its range, and cooled back down to the ice-point, the bulb will remain slightly enlarged for a time depending on how high and for how long a time it was heated. In precise testing, thermometers should be used at progressively higher temperatures and not first high and then at an intermediate point. Further details on these characteristics will be found in the A.S.T.M. Standard "Methods of Testing Thermometers" as described by Mueller and Wilhelm.

The industrial form of mercury-in-glass thermometer in which the bulb and stem are heavily protected by a sheath and case, and possibly constructed to screw into a socket, cannot be expected to provide the accuracy obtainable from a bare thermometer. The mass of metal surrounding it adds a great deal to its lag and to immersion errors. For this reason it is calibrated under conditions approximating those which may prevail during its use. The exposed parts should not be subject to strong drafts nor on the other hand should they be wrapped in extra insulation to protect them from drafts. It is well to repeat that these thermometers should not be installed where the fluid medium is apt to be stagnant, because in many cases a large amount of heat must flow to the bulb to keep it up to temperature.

Pressure-spring Thermometers

All thermometers in this class consist of a metal bulb connected through a small-bore metal tube or capillary to a thin-walled flattened and coiled metal tube, closed at the far end, which unwinds with increasing internal pressure and moves a pointer or pen-arm. If this pressure system is partly filled with a relatively volatile liquid, so that the free surface of the liquid is in the bulb, then the pressure will always correspond to the temperature. There will be no error of capillary and spring temperatures provided that these are constantly above or below the temperature of the bulb. The scale of these so-called vapor-pressure thermometers is very far from uniform. This makes it difficult to apply corrections, and careful attention should be afforded if any attempt is made to alter the mechanism attached to the pressure spring.

If the system is completely filled with a liquid such as mercury, under pressure enough to keep it from vaporizing at the highest temperature showing on the scale, as in the mercury-in-glass thermometer, the result is much the same as with the latter. Unless compensating means are em-

(Continued on Page 542)

METROLOGY
The Science of Measurements

By S. R. WILLIAMS
Professor of Physics, Amherst College

METROLOGY is "the science of, or a system of weights and measures." (Webster's New International Dictionary, 1936.) It is "the science that treats of systems of weights and measures, or of units of measure." (New Standard Dictionary of the English Language, 1938.) A metrologist is one who specializes professionally in the units whereby measurements are made. There are only a handful of professional or full-time metrologists in all the world, but all of us have been part-time metrologists since childhood when we measured how far Tommy could jump, how much Harry could lift, how long Jimmy could stay under water.

In order for one to make quantitative measurements it is necessary to establish units, in terms of which a magnitude* can be measured. To be effective, the unit must be simple and easily and accurately reproducible.

As man progressed in the arts and sciences in his upward climb it became more and more essential that he have some system of weights and measures. Even on a barter system, amounts of materials had to be evaluated in some way. Our systems of weights and measures, like Topsy, have "just growed up."

In the early days the king's foot or his forearm served as the standard unit of length. See Fig. 1. These were the visible, tangible units, back to which all other measurements of length could be referred. Even today the housewife will stretch a piece of cloth from the point of her nose to the end of her extended fingers and declare that she has a yard of the material. Inasmuch as the length of the king's foot or his forearm varied when a new king came to the throne, it soon developed in man's thinking that something more universal should be adopted.

Our modern yard length is the outcome of this thinking. The English yard, divided into three equal parts, is an approximation to three times the length of the average king's pedal extremity, one times the length of his arm. In order to have some standard of length a bar of metal three times

*"That-which-is-measured" must *be* a bigness or smallness . . . a *magnitude*. . . . The result of a measurement is a numeral, a mathematical *quantity*. (Behar, "Fundamentals of Instrumentation," pages 28-29.)

Fig. 1. "One Yard" was the length of the King's arm.
[This may be a copyright drawing but neither Dr. Williams nor we know whom to credit, though we should like to.—INSTRUMENTS]

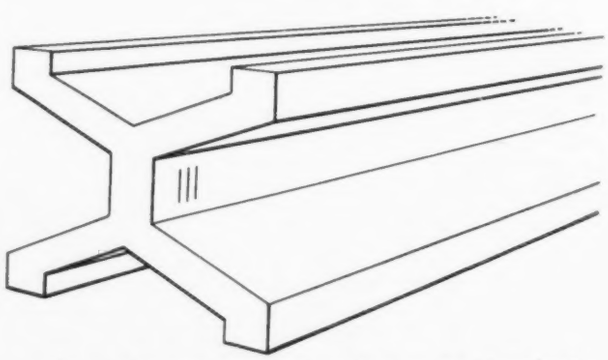


Fig. 3. The cross section and markings on the international standard meter—a line standard. The rulings are microscopic lines in the "trough" of the bar near each end.

Fig. 2. One of the original thirty bars now kept at the International Bureau of Weights and Measures. The bar is protected by a wooden case, which in turn fits inside a metal cylinder with a screw cap. Meter No. 6 is the authorized International Standard of Length. No photograph of it exists. No. 26 is employed for ordinary comparison work.

Fig. 4. This photograph shows National Standard Kilograms Nos. 4 and 20. No. 20 on the right, uncovered, is the primary standard of mass for the United States.

that of the foot—which is to say, the yard—was produced and the yard became the standard unit of length in England and is still used in England and America.

In this series of discussions we shall deal only with physical measurements. For such measurements there are three fundamental units in terms of which all physical magnitudes may be expressed. These are the fundamental units of Length (L), Mass (M), and Time (T). There are no units back of these three. These three are fundamental. To represent these fundamental units of physical measurement we must have standard units. They must be physical embodiments of these three fundamental units. In the process of time the civilized countries of the world have officially recognized one system of standard units for making physical measurement which is known as the metric system. It is a decimal system as well, which offers a great deal of convenience in calculations.

It is a fairly long story, that of how our standards were finally made and defined, but it will add to brevity and clarity to say that the three standards for the fundamental units of length, mass and time may be defined as follows:

1. LENGTH—The standard of length is the meter and is defined as that distance between two transverse lines marked on a certain platinum-iridium bar preserved in the International Bureau of Weights and Measures near Paris, France. See Fig. 2. Fig. 3 shows the cross section and markings on one end of the International Standard of Length.

Fig. 5. Kilogram No. 20, the National Standard of mass, a cylinder 39 mm. in diameter and 39 mm. high, with slightly rounded edges, iridium. It was furnished by the International Bureau of Weights and Measures in pursuance of the Metric Treaty of 1875. Early in 1937 it was taken back to Paris for recomparison with the International Standard. The most careful tests showed that the United States Standard had changed by only one part in fifty million during approximately fifty years.

Fig. 6. Interior view of the vault at the National Bureau of Standards in which the standards of length and mass of the United States are kept. Dr. Lyman J. Briggs, Director of the Bureau, is shown holding the National Standard of length, Meter No. 27. The national standard of mass, Kilogram No. 20, is under double bell jars on the center of the second shelf in the case. Both of these standards are made of an alloy of platinum and iridium. They were supplied to this country by the International Bureau of Weights and Measures.

If one takes the distance from the center scratch of the three shown to the middle one of the three on the other end, that distance is defined as the standard meter of length when the bar is at zero degrees Centigrade. Every civilized country in the world has one or more bars made as nearly like this International Standard as it is possible to make it and these prototypes serve as the Standard Unit of Length for that particular country. Originally the meter

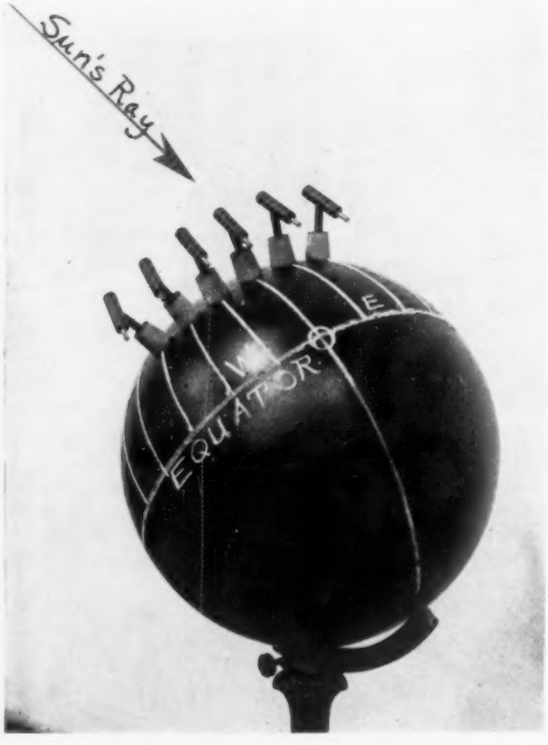


Fig. 7. The globe represents the earth laid off with meridians spaced 15° or 1 hour apart. An observer at each telescope would see the star appear on the cross wire of this instrument one hour later than his neighbor to the East. The prime meridian is designated as the one crossing the Equator at 0.

was supposed to be the one-ten millionth part of the Earth's quadrant, but inasmuch as the Earth's quadrant could never be accurately measured the International Congress of Weights and Measures simply defined the Standard Length as the distance between two certain fiducial lines on a certain platinum-iridium bar when at the temperature of zero degrees Centigrade.

2. MASS—In an analogous fashion the same International Congress of Weights and Measures defined the Unit of Mass as the mass of a certain platinum-iridium cylinder also preserved at the International Bureau of Weights and Measures and which they called the Kilogram. Fig. 4 shows the duplicates owned by the U. S. A. and preserved at the National Bureau of Weights and Measures in Washington, D. C. Fig. 5 is a close-up of the American national standard, while Fig. 6 shows how our American standards are protected at the National Bureau of Standards. Originally the Kilogram was supposed to be the mass of 1000 cubic centimeters of water, but it simplified matters to define the Standard Unit of Mass as the mass of a certain definite platinum-iridium cylinder preserved in the International Bureau of Weights and Measures, near Paris. No photographs have ever been taken of these International standards, so only the Standards for the U. S. A. are shown. The International Standards are inspected from time to time by the International Committee on Weights and Measures when they meet. The standards are kept in subterranean vaults under three (3) different locks and keys. One key is held by the Director of the International Bureau of Weights and Measures, one key is in the hands of the Director of the Archives of France, and the third is held by the President of the International Committee on Weights and Measures. The standards cannot be inspected unless these three keys are present at the same time. The importance of these standards is shown by the care with which they are preserved.

3. TIME—The Standard Unit of time is the second. It is defined as the 1/86400 part of a mean solar day. Due to the motion of the Earth in its orbit about the sun the length of the solar day varies. Roughly it is the time it takes the Earth to rotate upon its axis. If one measures the time from when the sun is directly over our meridian until it is directly over it the next time, that will be called a solar day. If one takes the average of all the solar days in the year, that will give the average length of a solar day and 1/86400 of this period is the second.

Fig. 7 shows how one may think of a light ray coming from the sun and entering an observing telescope set up at some fixed point on the earth's surface, say on the prime meridian as shown in Fig. 8. As the earth rotates from

Fig. 8. The late Professor Dayton C. Miller, standing on the Prime Meridian line of the earth at Greenwich, England, and looking up at the transit instrument by which the time of the earth is set.

west to east, the time which elapses between the instant when the ray of light from the sun coincides with the axis of the telescope until it does so again is a solar day. It is understood, of course, that the telescope axis lies in the plane of the meridian.

The meridian at Greenwich, England, has been fixed as the prime meridian and a line is drawn on the ground representing this meridian. Fig. 8. Directly over this line is a transit instrument (telescope) by which time is taken from the stars in their apparent motion about the earth. The time it takes from the instant a star is directly over the prime meridian until it is again over the same meridian is called a sidereal day. If we take 1/86400 part of the sidereal day we obtain the sidereal second.

1 Sidereal Second = 0.99727 mean solar second.

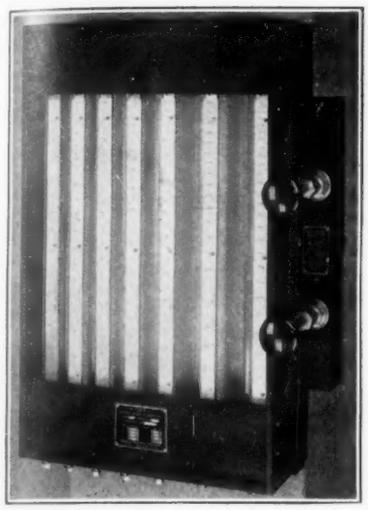
While we actually take time from the stars we still go by the sun, and use the mean solar second as our standard of time. We still worship the Sun!

Our Standards for the fundamental units of measurement of physical magnitudes are, therefore:

The Meter for Length
The Kilogram for Mass
and The Second for Time

All other units are built up out of these fundamental units.

HOW FAR CAN YOU READ THIS SCALE?→



This is one of seven scales used on a Type VII Multiple Stage Fluted Guide Flow Indicator. The total scale length for the seven stage instrument is 10½ feet within a space 18" wide by 18" high. The total flow range is from 5 to 4000 pounds of fuel per hour.

This Flow Indicator is Used Exclusively by the Largest Aircraft Carburetor Manufacturers.

The Fluted Guide Metering Tube, moulded of Pyrex glass, is the outstanding improvement in variable-area, flow rate indicators in recent years.

It is an exclusive feature and is the result of nearly twenty years experience in this field.

• • •

THE TYPE VII FLUTED GUIDE FLOW INDICATOR

SPECIFICATIONS

Weight	110 lbs.
Height	28¾ in.
Width	21 in.
Depth	7¾ in.

CAPACITY
(lbs. per hr.)
Type VII 5-4000
Type VIII 5-7000

Intermediate capacities are obtained by selecting any one stage or two or more consecutive stages.

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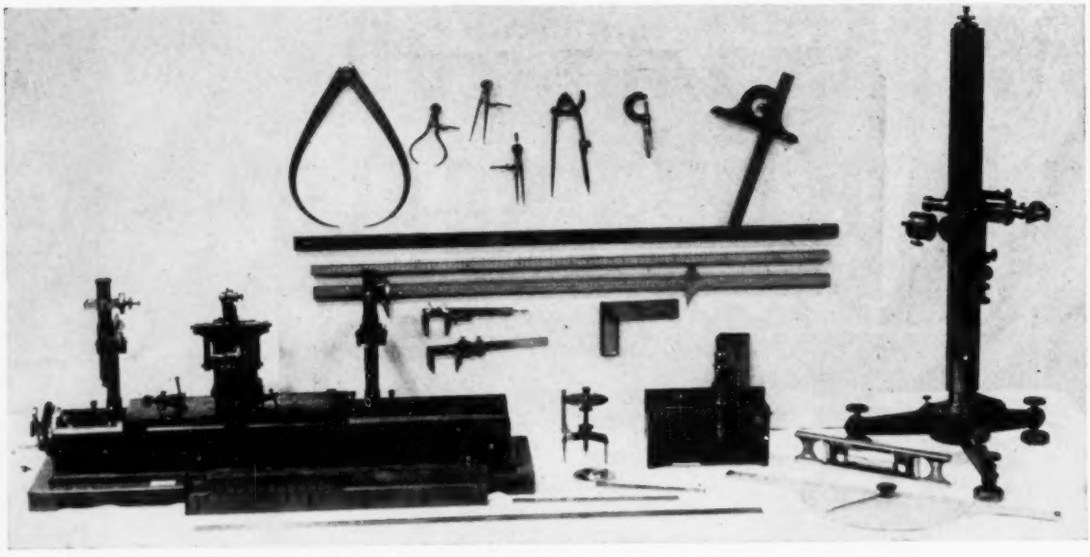

Fig. 9. LENGTH—Various devices for measuring length.

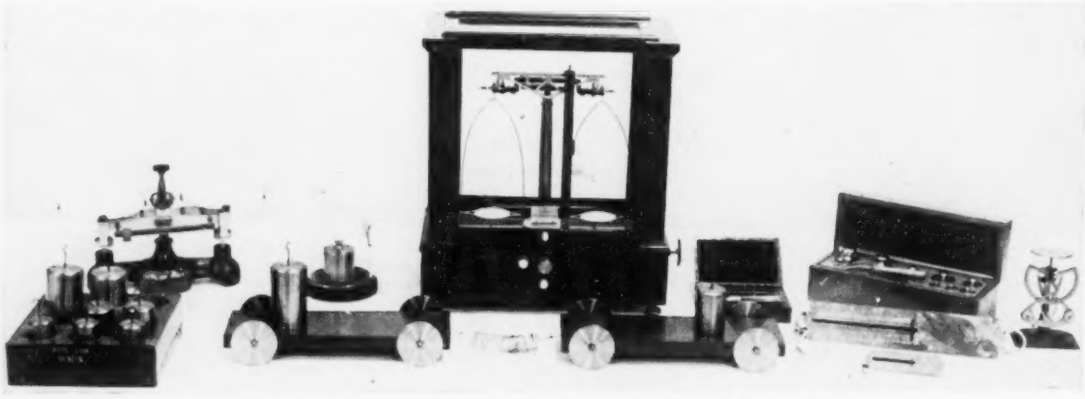

Fig. 10. MASS—Various devices for measuring mass.

In Fig. 9 are shown various devices for measuring LENGTH under different conditions. They may be listed as follows:

1. Carpenter's Square
2. Try Square
3. Standard Meter Bar
4. Micrometer Caliper
5. Vernier Caliper
6. Inside Calipers
7. Outside Calipers
8. Steel Measures
9. Wooden Scales
10. Carpenter's Folding rules
11. Cathetometer
12. Comparator
13. Level
14. Spherometer
15. Gravity Protractor
16. Model Vernier
17. Steel Tape
18. Compasses

Linear and circular dividing engines and range finders would constitute additional and interesting material.

In Fig. 10 may be seen items for measuring MASS:

1. Standard Kilogram
2. Sets of brass weights
3. Platform balances
4. Spring balances of various designs
5. Fine Chainomatic Balance (Becker)
6. Letter scale
7. Steel tape
8. Inertia carts

Fig. 11 shows several devices for measuring TIME:

1. Metronome
2. Electric Clock
3. Tuning Forks
4. Stop Watches
5. Model Balance wheel
6. Steel Bars for Longitudinal Vibrations
7. Second pendulum actuated by weight and escapement
8. Model of earth with transits on it for taking time from the stars (See Fig. 7)

To these might be added the crystal oscillators now used in precision clocks and for controlling the frequency of radio transmitters.

In England and in general use in this country the Standards for the fundamental units of Length and Mass and Time are:

The Yard for Length
The Pound for Time
and The Second for Time

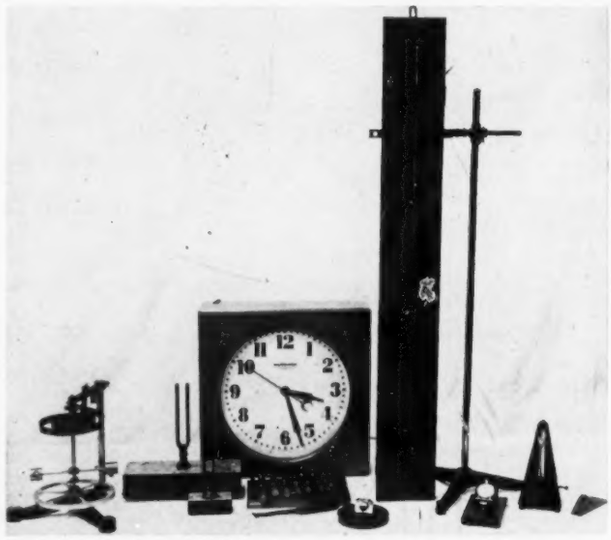

Fig. 11. TIME—Various devices for marking off equal intervals of time.

They are defined in a manner analogous to the Standards in the metric system, but are not officially recognized by the International Congress of Weights and Measures as are the Metric Standards. The physical embodiments of the standard yard and pound are preserved in London.

When we come to electrical units of measurements it will be seen that they are all based on Metric Standards, and are not based on the English units. The metric system of units is distinctly the units of scientific measurement.

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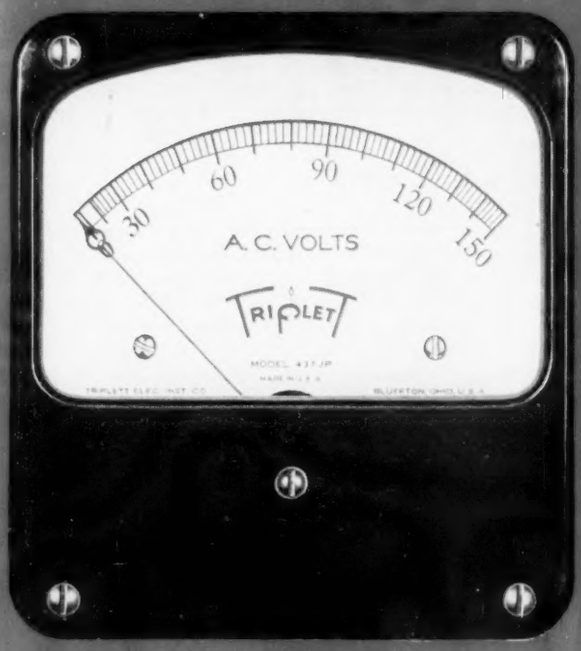
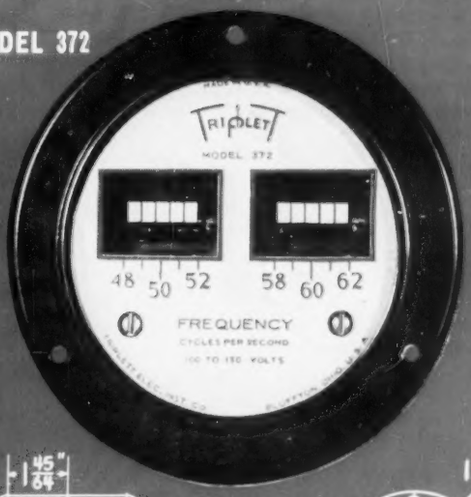
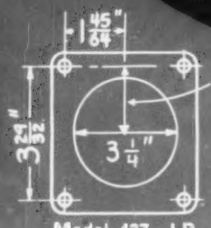


MODEL 437-JP

MODEL 372





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TRIPLETT

Some Pot Shots at This Relative Thing Called "PRECISION"*

By I. A. HUNT

Federal Products Corp., Providence, R. I.

MR. Chairman and gentlemen of the Precision profession. Please note I said profession—with due and proper consideration—because one who follows a profession is one who usually spends his time practicing rather than actually finishing anything. You know how it is with those who practice medicine, law, etc.: when they get through practicing on you, you are usually broke physically and mentally and financially and in a worse jam legally, as the case may be.

In your case it may be a little different; nevertheless, you do *practice* precision because you never really *are* precise. You used to think you were precise when you hacked away with a file and you think you are now because you've got used to looking at thousandths and tenths of thousandths of an inch in the face without getting cold feet. But don't forget there are still millionths to fool around with. So it's all very relative, this thing called precision.

Human beings are so prone to say "*no*" to new ideas. We know the old ideas, our old habits, our old tricks and our old methods but we argue back when it comes to the new idea. A man with an idea is so often a prophet without honor in his own country or shop. In spite of all this, I

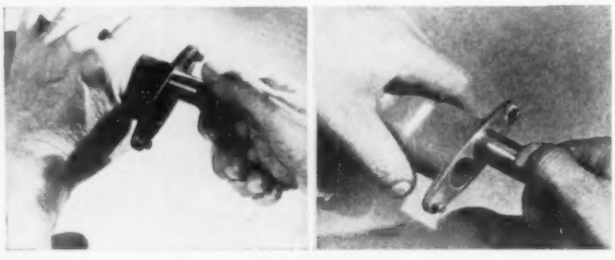


Fig. 1

propose to offer you a few interrupting thoughts. I will proceed to take the shirt off the obvious, and display it in all its nakedness for you to observe. I frankly admit that I am going to attempt to sell you an idea or two and in doing so, I will have to talk selfishly, for after all *precision* is our business and yours. We are all interested in it as never before to the *n*th degree.

What is Right?

Across the top of one of the tremendous airplane plants in this country there is, or there was, a mammoth sign hundreds of feet long which read as follows: "Nothing Short of Right is Right." The older I get the more difficult I find it is to know just what is right. I believe determining what is right is the biggest job you engineers have to do. Yet what a tremendously relative thing it is, this matter of what is right. Dr. Einstein has little on us!

It is not my intention to explore theoretical labyrinths. There is of course a definite need for such discussions, but I am not the man to do it. On the other hand, you engineers need to have your noses pulled off the grindstone now and then in order to take a look at what's around.

As I say the word "precision," each one of you has a different conception of the word, according to your experience with it. Some of you undoubtedly have a far greater idea of precision than I have: you have fussed with it, sweated over it and licked it. Others of you haven't seen anything yet.

*A talk delivered before the Hartford Society for Measurement and Control, Hartford, Conn., Sept. 15, 1942.

It is a truism that no two men are alike. This is true in general and it is true of machine operators, or of inspectors. They have different degrees of nervous and muscular endowments. Their nerves tell them how a gage feels on the workpiece. And yet you expect them to inspect down to thousandths of an inch and finer. You set up tolerances for the workpieces that have got to fit one another and you set up limits for the fit itself. These you determine by a consideration of the requirements of the finished job based on the quality, the material, the cost. You consider the wear on the gages themselves, you consider temperatures, but what, and how much, do you allow for the man—the human being who is going to sit in judgment of those pieces of work? Fig. 1 shows the hands of two men, one sensitive and the other sluggish or heavy.

The sense of touch is indeed a very relative thing. It cannot be magnified except by training, which takes time; and skill, which varies even after training. Look around your own shop and see if it doesn't. Vision is also relative, but we correct it with eye-glasses. But did you ever see anything that magnified the sense of touch? Visual gages magnify facts so you can see them. That is why visual gages have leaped ahead. There are so many reasons for visual gages that you haven't thought about, that I believe I shall be pardoned if I tell you about their possibilities. We are all interested in winning this war—in getting things done faster and sufficiently right to meet the need. If I can show you how to avoid inspection trouble, how to

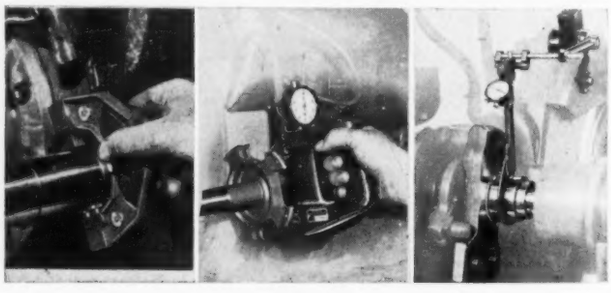


Fig. 2

inspect more accurately and faster, I believe you will pardon my sticking to one subject which I am in a position to observe from many angles.

In Fig. 2 you see three illustrations emphasizing the importance of visual gages. The gage at the left is mute. Think of a blind man as he reads his Braille book with raised letters. You undoubtedly regard him with pity; yet you still provide many inspectors with Braille type gages, so to speak. Or have I given you an idea here? Why not try out some blind men as inspectors? Maybe their highly-developed sense of touch would be a big improvement. For after all I must admit, though reluctantly, that feeler gages do have an economic place in inspection.

But notice how the middle gage automatically tells you visually how right or wrong you are.

And then look at the gage on the right. Here you watch the work grind down to size; you don't stop to mike it; you don't over-grind. Result, you save time, you save stock and you produce more and right.

The Human Element Is Too Often Forgotten.

Two points stand out in the articles and discussions I have read and listened to concerning gaging. One is, that in almost every article on precision maintenance the mechanical

details are carefully covered but the human element is seldom touched upon. Fig. 3 is a list which appeared in an article by Mr. Hitchcock in *Modern Machine Shop*. It gives twenty-one human factors all of which tend to cause failure to do work as required. Twelve of these twenty-one causes

TABLE I

	Underlying Cause	*Weight*
1.	Negligence	339
2.	Speed	265
3.	Over confidence	217
4.	Lack of knowledge	214
5.	Worry	208
6.	Thinking of things foreign to the job	192
7.	Improper supervision	168
8.	Physical defects of men	160
9.	Fear	150
10.	Defective equipment	144
11.	Lack of cooperation	142
12.	Wrong mental attitude toward safety	140
13.	Horseplay	106
14.	Misunderstanding of orders	91
15.	Disobedience of orders	61
16.	Lack of emotional control	56
17.	Poor judgment	51
18.	Bullheadedness	42
19.	Lack of interest	36
20.	Recklessness	25
21.	Outside interference	15

Fig. 3

can be directly associated with inaccurate gaging and all twelve are directly due to the human element.

You set up carefully considered standards; you take all kinds of care in setting standards; but it is my observation that you do not often enough remember the human element.

Wear

On the other hand, a factor which I do find mentioned time and again is that of wear. Now everything wears. Gages are no exception. Solid gages when worn are no longer of any use. Visual gages, on the other hand, although they can and do wear, can be reset. Consequently wear does not stop their continuous use.

How Gage Applications May Be Classified

There are of course thousands of gage designs. Federal has in its files over 6,000 special designs. When I mention these thousands of designs you probably imagine thousands of dimensions. Yet, all of these classify themselves into a few simple dimensions. The following is my adaptation and elaboration of an original classification by Capt. R. A. Bowman of the Pittsburgh Gage Laboratory of the Army, as published in *Instruments*:

1. *Inside Dimensions* (Including roundness)
   Cylinders, holes, inside dimensions of recesses, in castings, forgings, bottles, patterns.
2. *Outside Dimensions* (Including roundness)
   Shafts, pitch diameters, thickness, width, parallelism.
3. *Offset Dimensions*
   Depths of slots, splines, height of bosses, flanges, etc.
4. *Alignment or Position Dimensions*
   Location of holes, studs and other details.
   Concentricity or eccentricity of diameters.
   Lead of threads, etc.
   Straightness.
5. *Angle*
   Tapers, bevels, etc.
6. *Profile*
   Roundness, chamfers, fillets, cams, shell ogives.

Proper Use of Dial Indicator Gages

I shall now comment on some phases of dial indicator gages. I am compelled to show you photos taken largely of our own gages, because of the difficulty in obtaining photographs in outside plants under present conditions.

One of the most common faults in applying Dial Indicators is the carelessness in maintaining *rigidity*. This is one of the most common mistakes found in the application of dial indicators. The indicator should not be supported by a slender rod, too far away from the indicator, allowing the rod to spring. In such a case the indicator, unless it is a very sensitive one, may not move until after the rod has begun to bend, with the result that the inaccuracy of the work will not be indicated in the indicator. This is most deceptive on a piece of out-of-round work where the change is gradual. There are other cases similar to this where rigidity is too often neglected. It may not be a rod which is too flexible to support the indicator, it may be in the structural design of the gage itself.

Concentricity

Inspection of parts for concentricity and diameter is frequently misunderstood, due to habits formed by some users. It is a fact that men will put work in a single comparator and check it for diameter and roundness; but when it comes to checking a piece with *more than one diameter*,

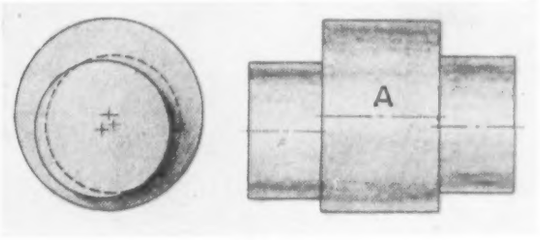


Fig. 4

they make the following mistake. This is best illustrated in the case of shell inspection which is so important at the present time. Assume that we have a piece similar to that illustrated in Fig. 4. There are three diameters, and we want to inspect them for concentricity with each other and for diameter. If we place these pieces in a V block and check them for concentricity with each other, as shown in Fig. 5, our inspection will be quite all right. The V block acts as a reference point as well as a support to the workpiece. The indicator then shows up any lack of concentricity

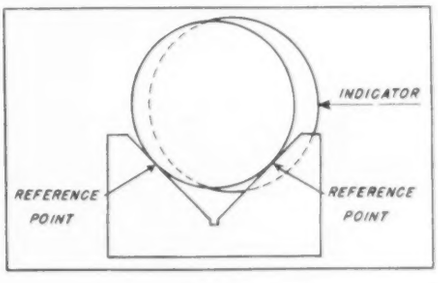
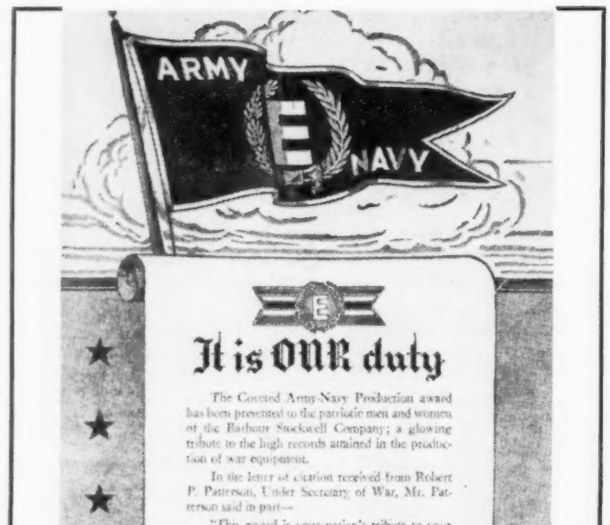


Fig. 5

or of the eccentricity of the diameters, in other words. But the mistake is that men also try to inspect several *diameters* with this same arrangement, and it cannot be done.

In order to inspect each diameter with indicators placed on these various diameters it is absolutely necessary that the diameters be concentric with one another, but this is seldom the case. In order to inspect for diameter, each of the different diameters must be inspected *separately*, and this we do as shown in Fig. 6. Here the reference points and the indicators for each one of the different diameters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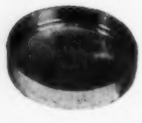

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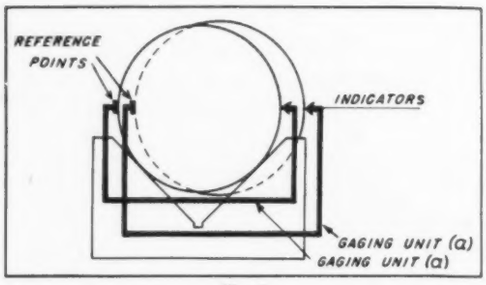

Fig. 6

Fig. 7

Fig. 8

are each a single and independent unit. The V block acts merely as a support.

How this appears in actual gages is shown in Fig. 7 which is a concentricity gage and Fig. 8 which is a diameter gage. Note the flat springs which support the indicator units in the latter illustration. Also note on the concentricity gage how nine diameters are being inspected simultaneously: both inside and outside diameters.

In designing dial-indicator gages, friction, inertia and lost motion are all too frequently ignored. Fig. 9 illustrates that point very well indeed. This early experimental design has several bad features about it. In the first place the rocker arm which measures the concentricity of the inside of the shell consists of a long heavy bar of cold-rolled steel; such a heavy bar cannot be very sensitive because it is bound to have a lot of inertia. In the second place it is mounted on a stud, and the weight of this bar causes a great deal of friction on that stud. In the third place there is bound to be some play or lost motion in the fit between the bar and the stud. All these three items cause inaccuracy so that the motion of the contact point which touches on the shell is not transferred accurately to the indicator.

Note that the shell master rests on ball bearings or roller bearings. These bearings must of necessity have some clearance so that they will rotate. Here is a chance for inaccuracy in the bearings themselves. The shell is not heavy enough to warrant the use of these bearings. A much larger

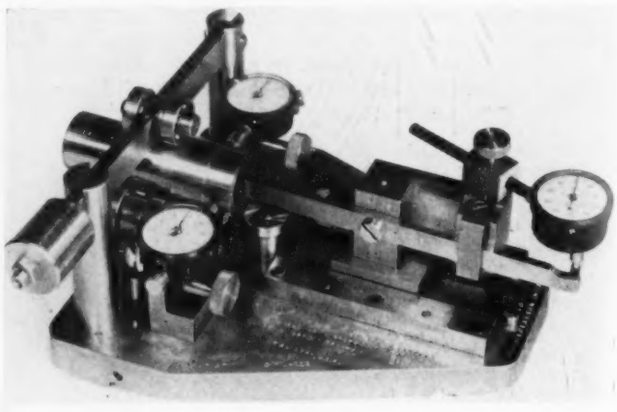

Fig. 9

shell than this could easily be mounted on solid V blocks which would be more positive than the bearings.

Note also that all indicators are rather crudely mounted, and the stems of the indicators are not protected in any way so that unless the shell is placed in the gage carefully, the spindles of the indicators can be easily bent through carelessness, causing an increase in friction and inaccuracy.

On the other hand, note that the indicators on the two previously-shown shell gages (Figs. 7 and 8) are protected with stops so that if a shell is carelessly placed in the gage, it will not push the contact points beyond the range of the indicator—a condition which would naturally cause undue pressure on the mechanism of the indicator. Also notice that the indicators themselves do not contact the work but that auxiliary contacts come between the indicator and the shell, thus eliminating any side thrust on the indicator rack spindles which would cause friction or binding of the rack spindle resulting in inaccuracy.

Entirely too often, gage engineering inspectors and men in a similar capacity seem possessed with the idea that dial indicators, or any other visual gages for that matter, are to be used simply for great accuracy. We frequently hear the objection that the work is not accurate enough to require the use of dial indicators.

One of the most popular gages we manufacture is not known as an accurate gage at all. It is the most popular gage because it is so handy and convenient that it is easier to use it than it is to take a chance. This is a caliper gage with a dial indicator attached. This gage has been used for checking everything from the thickness of the walls of glass bottles to the thickness of walls of airplane engine cylinders (Fig. 10).

Fig. 11 illustrates another way in which time can be saved through the use of dial indicators. Imagine trying to inspect the inside of a bushing for diameter, roundness and taper; and at the same time inspecting the outside diameter

(Continued on Page 542)

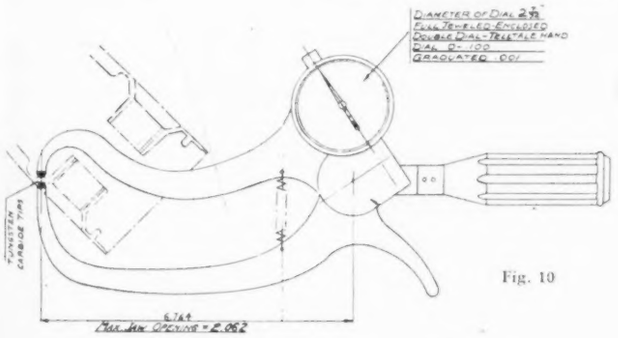

Fig. 10

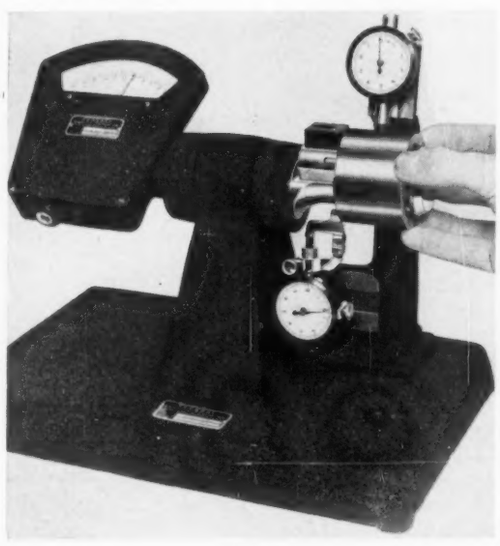

Fig. 11

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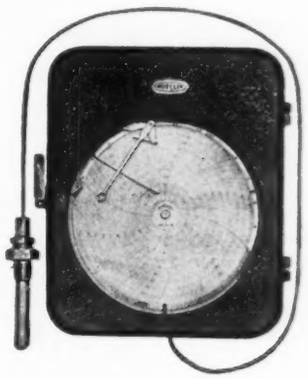

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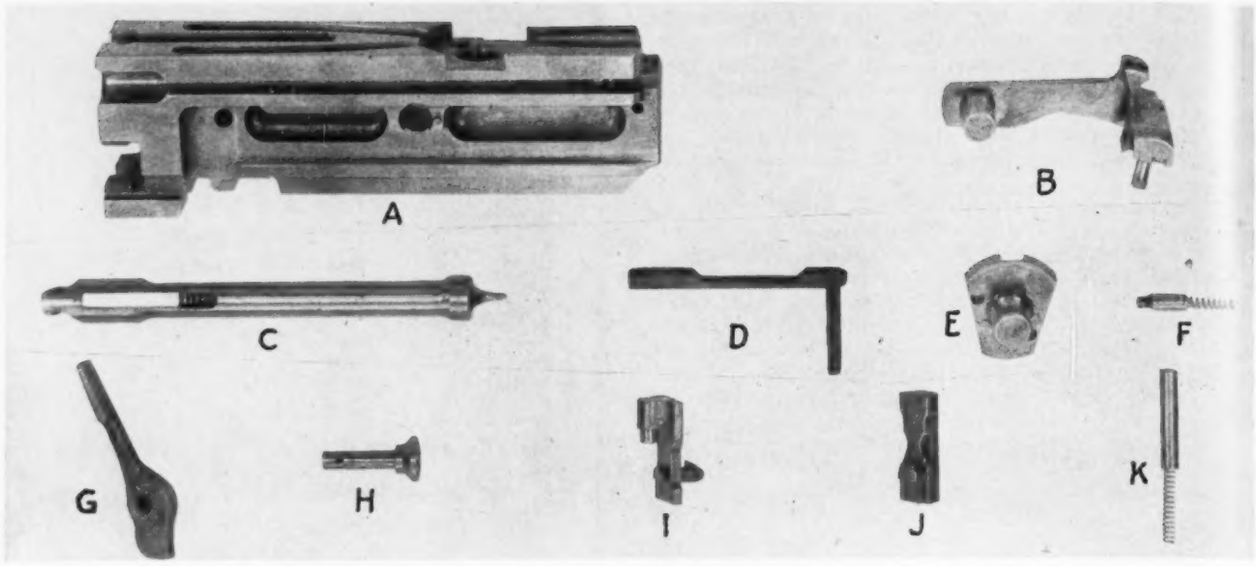


Fig. 1. Some of the 189 parts of the familiar "M 1919" (or "Browning") .30 caliber machine gun. A—bolt; B—extractor; C—firing pin and spring; D—sear stop; E—bolt switch; F—bolt switch plunger and spring; G—cocking lever; H—cocking lever pin; I—sear (with plunger and spring); J—sear holder; K—sear holder spring and plunger.

Methods and Equipment for the Inspection of Machine Gun Parts and Assemblies

By C. G. NELSON

Quality Engineer, Colt's Patent Firearms Mfg. Co., Hartford, Conn.

IT was the ingenious Eli Whitney who simplified the manufacture of muskets by standardizing component parts through the use of gages. Colonel Samuel Colt was one of the first to adopt this method in the manufacture of his revolvers. Thus were laid the foundations of modern gaging and inspection methods whereby manufactured components are standardized to the point of *complete interchangeability*. For many years Colt's enjoyed the distinction of being the only manufacturer of machine guns on this side of the Atlantic. Today the mating parts of the most intricate machine gun fit properly even though they are made in factories thousands of miles apart.

Today as in the days of Whitney and Colt, however, there is still one factor which cannot be predicted: the human element. This calls for the development of gages which are foolproof and easy to understand, and for the training of inspectors in the intelligent use of gages. It always has been a two-fold problem. War intensifies both aspects of this problem. In a year and a half our inspection staff has grown from 270 to 1500. Moreover, most of our inspectors have averaged only six to seven months' service to the company, because of the rapid turnover due to the draft. Our methods and our gages *must* be foolproof!

Still another factor which compels us to keep on improving both our training methods and our inspection methods is the enormous number of operations on an enormous number of different parts. Our principal products at this time, as many readers know, are the .38 caliber revolver, the .45 caliber automatic pistol, and various types of .30 and .50 caliber machine guns.

The .30 caliber water-cooled machine gun, for example, is made in several types. The familiar type mounted on a tripod and firing 5-600 rounds per minute contains 189 pieces. The .30 caliber air-cooled machine gun, used in combat vehicles and also in airplanes as either a flexible or fixed gun, fires 1350 rounds per minute. Various types of these guns will contain up to 250 pieces. Also in the caliber .30 class is the Browning automatic rifle, used as either a semi-automatic or a light machine-gun.

In the .50 caliber or heavy class, are the water-cooled tripod-mounted machine gun; and for use in aircraft and combat vehicles various air-cooled types capable of firing 900 rounds per minute. These .50 caliber guns have even more parts than corresponding types of .30 caliber guns.

Fig. 1 shows some (about one-half) of the parts of the "bolt group" of a .30 caliber machine gun. The mere description of the "bolt group" occupies several pages in the gunner's manual, so I shall not attempt it in this article. The reader will gain some idea of the inspection problems from a careful scrutiny of Fig. 1. I may mention, however, that it takes nearly 140 operations to produce this bolt (A) from raw bar stock. For machining alone, more than a hundred gages must be applied to it, some operations requiring 100% inspection at the machines—all this before the bolt is filed, heat-treated, the holes lapped and the ways ground, these operations requiring the use of about forty more gages. When the bolt has been finish-machined, final inspection takes over with about thirty-two more gages, which sum up all the key-points.

Most of our larger pieces are made from forgings, which are given 100% inspection for surface defects, form, and general perfection. When the forgings have passed inspection they are either annealed or toughened before machining. Since heat-treatment is done in batch furnaces or continuous furnaces with modern instrumentation to assure uniformity, only fractional inspection is ordinarily given for the correct Brinnel or Rockwell. These parts now having been heat-treated, they are moved to the Blanchard grinders, where 100% inspection is conducted.

Screws, pins, studs and rivets can be given a fractional inspection, say 10%, but practically all other parts—not only the large ones made from forgings but all the small *functional* parts—require 100% inspection at different operations along the line. For this, inspectors are stationed at the machines, each inspector passing on the work of several similar machines as it is produced.

Final inspection of sub-assemblies and groups requires special equipment and special methods.

Now the reader will not be astonished when I mention that the production of all parts for all guns keeps an in-

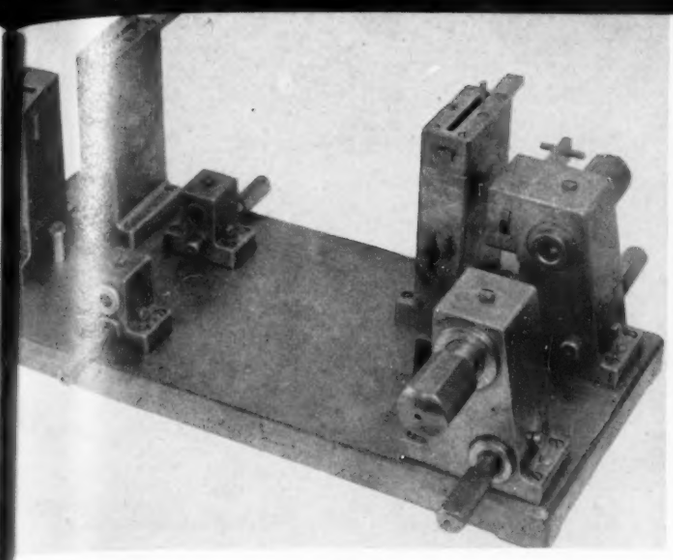


Fig. 2

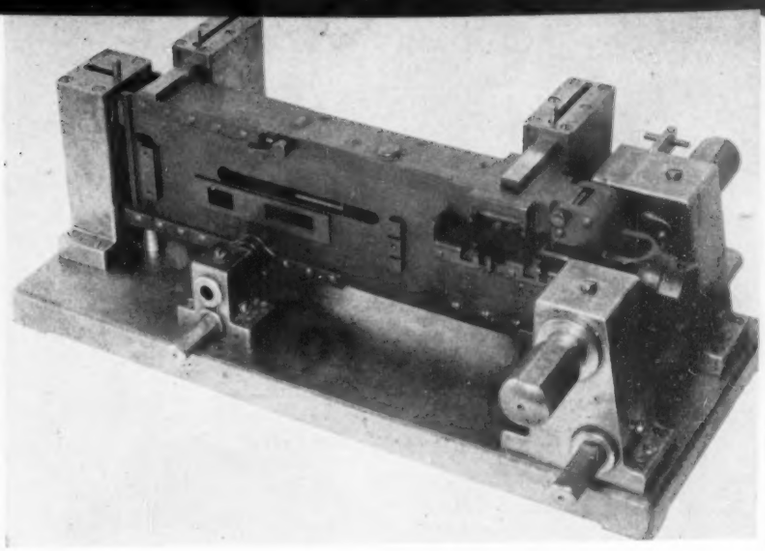


Fig. 3

spection crew busy twenty-four hours a day every day in the week.

In the remainder of this article there will be described a few examples of special inspection equipment. Needless to say, Colt's has a large number of *measuring* instruments, including recorders, but the readers of *Instruments* are already familiar with these standard items of laboratory and plant equipment. Moreover, the great majority of inspection operations are determinations rather than absolute measurements. These determinations must be made decisively: the answer must be "yes" or "no" without guesswork. These determinations must be made rapidly: there is no time to squint at a vernier or even to observe where a needle intersects the graduations on a dial. These determinations must be made by inspectors many of whom had never handled precision devices before: the equipment must be rugged, simple and designed to prevent "fatigue errors" toward the end of each shift.

Guns are different from other mechanisms, in that instead of taking measurements from a base line, dimensions are usually checked from a reference point which experience has shown to be the point from which to begin.

In airplanes, for example, the gun-mounts are welded in place. This means that we must have all guns standardized for quick replacement. The 12-point gage shown in Fig. 2 checks this, along with alignment and overall dimensions, also checking the position of the feedway, which must be held to a close tolerance, relative to the mount. Fig. 3 shows the gage in use. A comparison of Figs. 2 and 3, point by point, will reveal how the various sliding gaging members determine a number of positions and alignments.

Timing is just as important in a machine-gun as in an internal combustion engine. To guarantee that the timing will be within prescribed limits, the position of the trigger must be gaged in the case before assembly. In the fixed aircraft gun, the trigger is an electrically-controlled unit, clamped onto the gun, and operating from either side. In Fig. 4 we see the gage in position, checking the position of the sideplate-trigger slot relative to the trunnion block. The step in the sliding plug allows 0.010″ tolerance. The

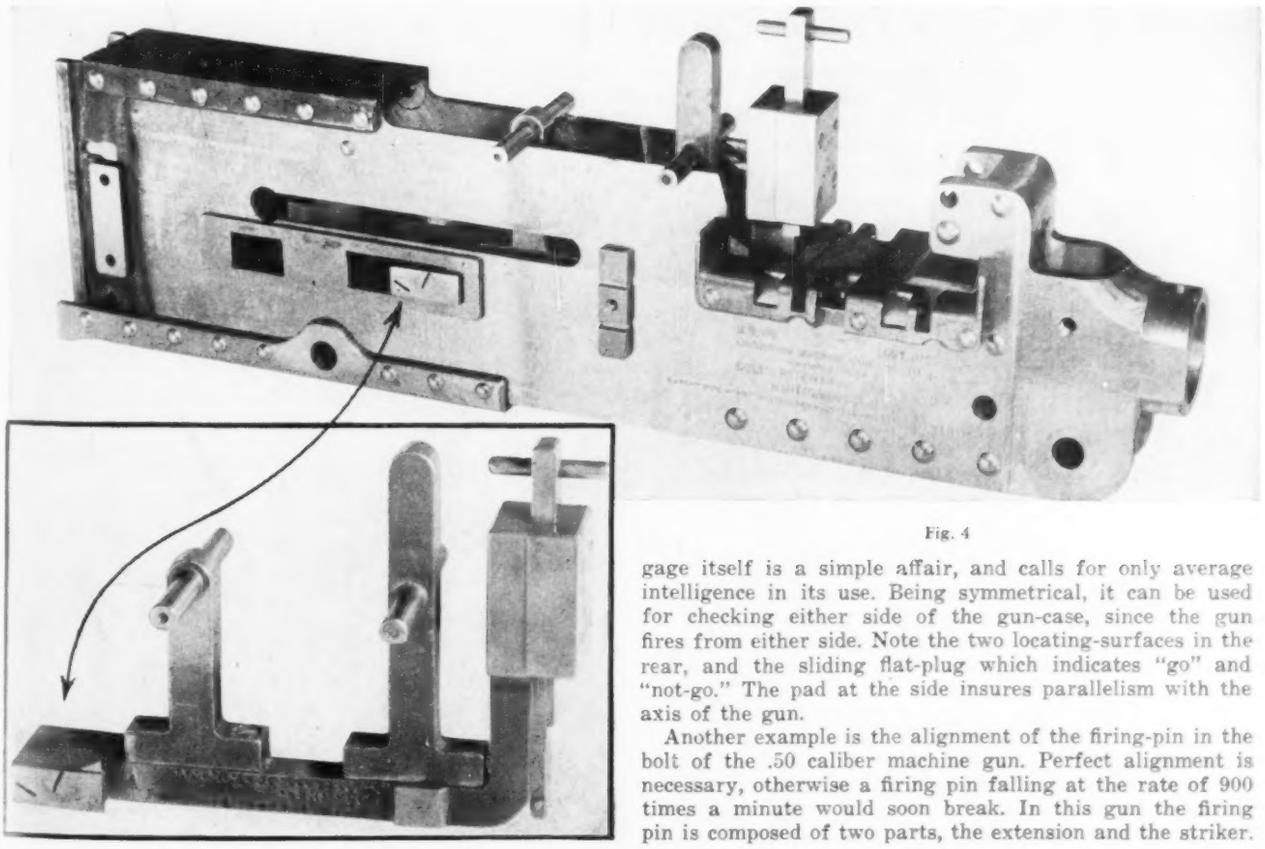


Fig. 4

gage itself is a simple affair, and calls for only average intelligence in its use. Being symmetrical, it can be used for checking either side of the gun-case, since the gun fires from either side. Note the two locating-surfaces in the rear, and the sliding flat-plug which indicates "go" and "not-go." The pad at the side insures parallelism with the axis of the gun.

Another example is the alignment of the firing-pin in the bolt of the .50 caliber machine gun. Perfect alignment is necessary, otherwise a firing pin falling at the rate of 900 times a minute would soon break. In this gun the firing pin is composed of two parts, the extension and the striker.

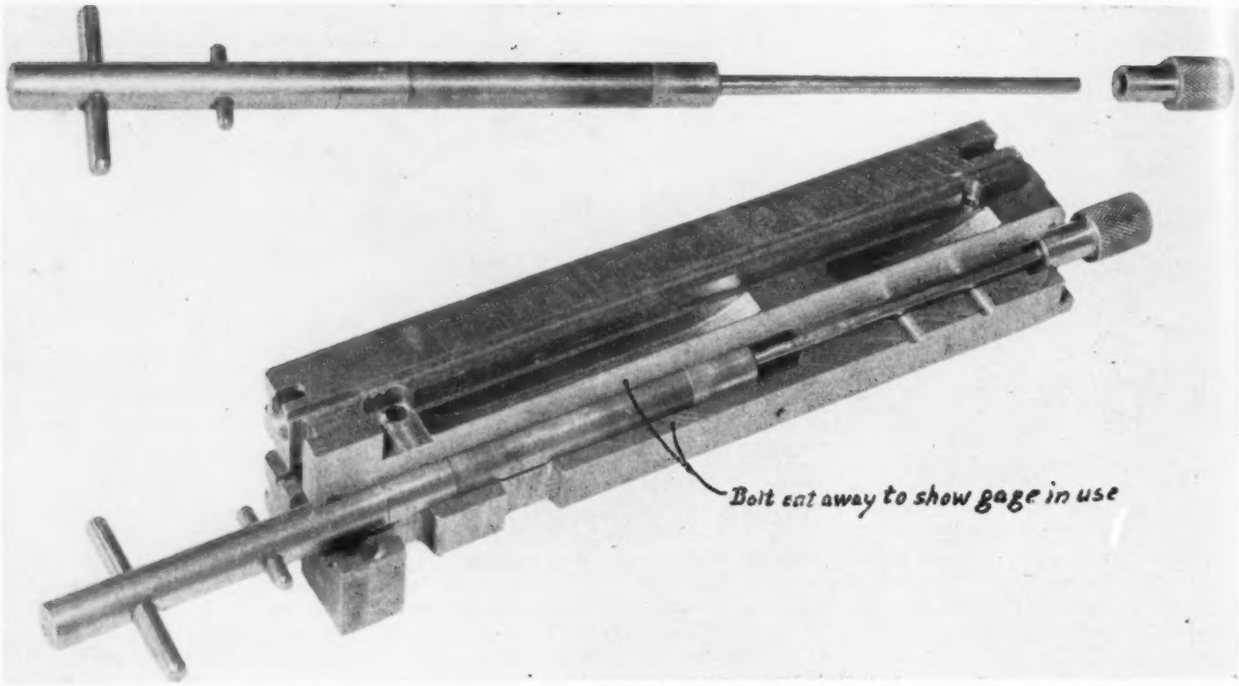


Fig. 5

Both parts must slide freely in the bolt, through which there is a shouldered hole. The gage shown in Fig. 5 anticipates this condition. The bushing provides the means of checking the alignment of a hole in the face of the bolt, which takes a hardened insert called the recoil plate. This simple gage then indicates the alignment of no less than three holes, yet it can be used to good advantage, quickly and with no great skill involved.

In order to insure that firing-pins will strike the center of the primer, alignment must be checked between the boltways and the recoil plate. If it were not for the simple receiver-gage shown in Fig. 6, this job would be one for a toolmaker. The gage holds the bolt in position to be checked by the pin.

There are five barrels turned out for every gun produced. This means that inspection must be quick but correct. Among other requirements, the barrel must be perfectly straight. In order not to depend only upon the eyes of the experts who do the straightening, we use a drop-plug after both reaming and rifling. This plug is a solid steel cylinder 8″ long for the .30 caliber and 12″ long for the .50 caliber. In either case, this plug must drop freely through the barrel, yet it fits with a maximum clearance of 0.0017″ and a minimum of 0.0002″.

Another point in the barrel, which must be carefully watched, is the chamber. The surface of the chamber must be perfectly smooth so that the high pressure of the burning powder, which amounts to 28 tons per square inch, will not force any of the brass of the cartridge-case into grooves or tool-marks. If this were to happen, automatic extraction of the empty case would be impossible and the gun would cease firing. For this reason, we employ visual inspection of the inside of the chamber. Since the hole is small, and dark inside, we use a small reflector, Fig. 7, which can be placed at right angles to the bore in such a way that the inside is illuminated, thereby allowing flaws to be detected. Fig. 8 shows a barrel cut-away to show the chamber and the reflector.

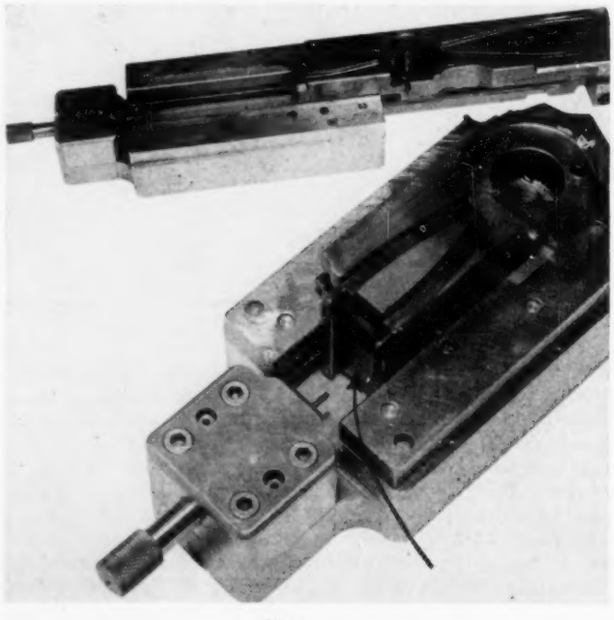


Fig. 6

Fig. 7

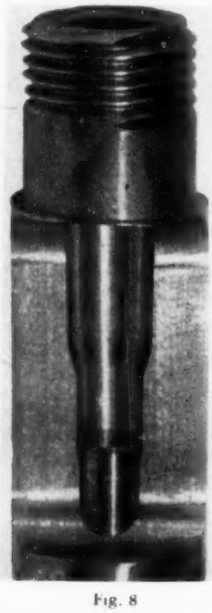


Fig. 8

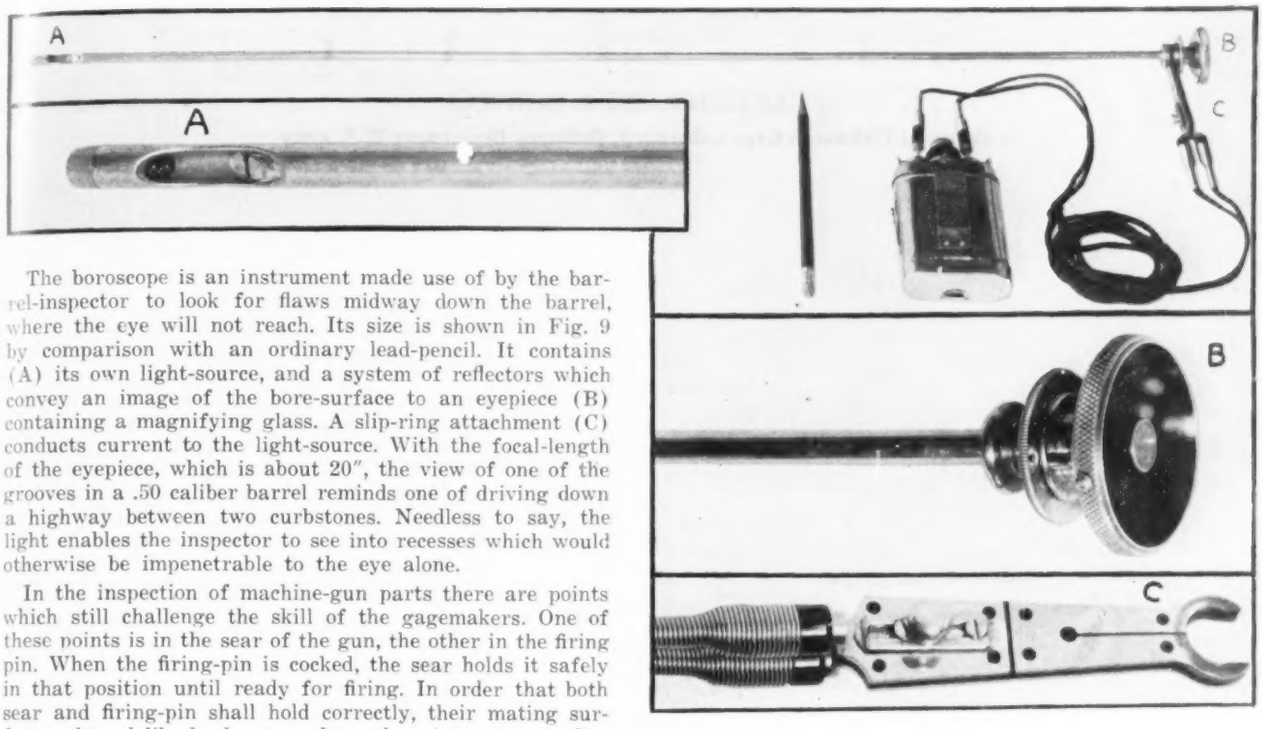


Fig. 9

The boroscope is an instrument made use of by the barrel-inspector to look for flaws midway down the barrel, where the eye will not reach. Its size is shown in Fig. 9 by comparison with an ordinary lead-pencil. It contains (A) its own light-source, and a system of reflectors which convey an image of the bore-surface to an eyepiece (B) containing a magnifying glass. A slip-ring attachment (C) conducts current to the light-source. With the focal-length of the eyepiece, which is about 20″, the view of one of the grooves in a .50 caliber barrel reminds one of driving down a highway between two curbstones. Needless to say, the light enables the inspector to see into recesses which would otherwise be impenetrable to the eye alone.

In the inspection of machine-gun parts there are points which still challenge the skill of the gagemakers. One of these points is in the sear of the gun, the other in the firing pin. When the firing-pin is cocked, the sear holds it safely in that position until ready for firing. In order that both sear and firing-pin shall hold correctly, their mating surfaces, shaped like hooks, must be undercut to prevent slipping. If this were not so, uncontrolled fire would result: the gun would run wild until the ammunition was exhausted.

To check this undercut, we now find it easier to use a shadowgraph than a steel gage of any kind. Not only does this reduce errors in judgment, but it permits volume handling not slowed down by the use of a standard gage.

The shadowgraph also pays for itself in checking firing-pin strikers. The striker must be smooth and ball-shaped in order not to puncture the primer. In the event that a rough striker found its way into a gun, the primer might rupture, and the resulting blow-back of gas could injure the operator. Fortunately, the shadowgraph will magnify any irregularity in the shape of the striker. It will also show whether the striker is bent as it is rotated in its support in the machine, thus accomplishing two purposes, which would otherwise take both time and skill.

From these few examples it might be inferred that Colt's is attempting to do away with skilled labor. Not at all. We still have a few skilled workmen. One of the choice jobs I have in mind requires working to zero tolerance. Surprising as this sounds, it is nevertheless true, since fitting barrels to revolvers requires just that. The front sight is brazed to the barrel before finishing. This means that the workman must qualify his threads in order to bring the sight up to correct position. One thousandth of an inch off would cause an inaccuracy in shooting of seven-eights of an inch at 15 yards. All our guns are fired and targeted before passing final inspection, and let it be said now that an error of this size is simply not tolerated.

Of course we have some scrap. Every modern factory, no matter how well manned or equipped, will admit this. Yet it is because of the efforts of such men as Whitney and Colt that modern American production methods have reached the point of turning out more precision machinery and better engines of war than the world has ever seen.

STOP!

Stop a moment for an urgent reminder and for TWO important NEW announcements . . . Excuse our "shouting" this way on an otherwise impeccable page of your favorite technical magazine, but this concerns you . . . The Call for Ideas on Speeding War Work was first published in our October issue and the response has been good (you ought to see the pile of special-delivery and air mail that came in today, the closing date, December 7th)—but not good enough! For example the President of a company which designs, makes and installs War Work Speed-Up devices promised us that he would send in some descriptions—but we have not received a single manuscript from him! He probably started his write-ups but did not finish them because he was too busy. So did you and so were you. Therefore the closing date is postponed to December 31. That's the first new announcement. The second is that cash will be paid for all War Work Speed-Up Ideas published in *Instruments*. Two dollars minimum for a brief description without diagrams; one or two additional dollars for each diagram, photo, etc. Our idea is not to pay for ideas (that's impossible) but simply to cover the preparation costs—expenses usually paid personally by an author who does not have the services of his company's typists, draftsmen or photographers. As good Americans, our readers don't want money for describing the War Work Speed-Up methods they know of. However, some may have been discouraged when they learned what professional typists, draftsmen and photographers charge.

Now then, hop to it! There's only a few days left. Although the closing date is the 31st, please send your description before Christmas so that your overworked editor will not suffer a break-down putting *your* article in the big January issue.

Ordnance Production Gaging

By CAPTAIN RUSH A. BOWMAN

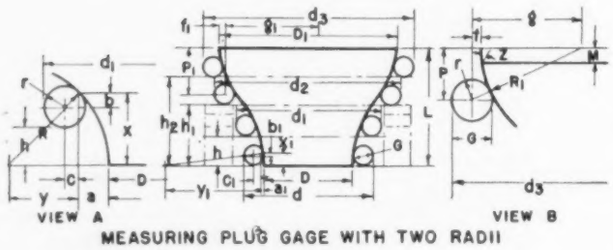
In charge of Pittsburgh Gage Laboratory, Ordnance Department, U. S. Army

CHAPTER VII
PROFILE DETERMINATIONS

Two types of gages provide inspection control for all profile determinations—the profile template and full contour. Occasionally when the volume of production justifies the cost of the equipment, an optical comparator with an appropriate fixture is used in place of a template but, as yet, it is relatively unimportant as a gaging device.

By far the most widely used gage for profile determinations is the template. This type is one of the most familiar to the layman because screw pitch gages, center gages and radius gages are types of profile gages. This type is almost invariably used when the surface being inspected is not a mating surface. Examples, the ogive of a shell, the boat-tail, etc. The template is also used at times when the surface is mating. Rounds and fillets are almost always inspected with a template even though the surfaces are mating.

The profile template gage determines the conformity of surface contour *along a particular line*. This is essentially a two-dimensional inspection. By inspecting at a representative number of positions, the general conformity of the entire surface is established. Profile gages are made to basic dimensions. Seldom if ever is a profile gage designed as a "not go," although it would be possible in the case of a simple radius gage. A check gage is usually provided with a profile template since actual measurement of a template is often quite difficult.



MEASURING PLUG GAGE WITH TWO RADII

D = SMALL DIAMETER OF GAGE
D_1 = LARGE DIAMETER OF GAGE
R = RADIUS AT SMALL END OF GAGE
R_1 = RADIUS AT LARGE END OF GAGE
G = DIAMETER OF MEASURING ROLLS
$r = \frac{G}{2}$ = RADIUS OF MEASURING ROLLS
L = LENGTH OF GAGE
M = DISTANCE FROM TOP OF GAGE TO CENTER OF ORIGIN OF RADIUS
h, h_1, & h_2 = HEIGHT OF GAGE BLOCKS ON WHICH ROLLS REST
d, d_1, d_2 & d_3 = MEASUREMENT OVER ROLLS

FORMULAE

$(R-r) : (h+r) = R : X$

$X = \frac{R(h+r)}{(R-r)}$

$y = \sqrt{R^2 - x^2}$

$a = R - y$

$b = x - (h+r)$

$c = \sqrt{r^2 - b^2}$

$X_1 = \frac{Rr}{(R-r)}$

$y = \sqrt{R^2 - x_1^2}$

$a_1 = R - y_1$

$b_1 = x_1 - r$

$c_1 = \sqrt{r^2 - b_1^2}$

$P = (L+M) - (h_2 + r)$

$P_1 = (L+M) - (h_1 + r)$

$g = \sqrt{(R_1+r)^2 - p^2}$

$g_1 = \sqrt{(R_1+r)^2 - P_1^2}$

$f = g - R_1$

$f_1 = R_1 - g_1$

$Z = R_1 - \sqrt{R_1^2 - M^2}$

$d = D + G + 2a_1 + 2c_1$

$d_1 = D + G + 2a + 2c$

WHERE d_2 IS LESS THAN $D_1 + G$ $(d_2 = D_1 + 2Z + G - 2f_1)$
WHERE d_2 IS GREATER THAN $D_1 + G$ $(d_2 = D_1 + 2Z + G + 2f_1)$ (IN THIS CASE $f_1 = g - R_1$)
WHERE d_3 IS LESS THAN $D_1 + G$ $(d_3 = D_1 + 2Z + G + 2f)$ (IN THIS CASE $f = R_1 - g$)
WHERE d_3 IS GREATER THAN $D_1 + G$ $(d_3 = D_1 + 2Z + G + 2f)$

NOTE— ROLLS FOR d_1 MEASUREMENT MUST NOT BE ABOVE AND FOR d_2 MUST NOT BE BELOW POINT OF INTERSECTION OF RADII R AND R_1.

Fig. 1

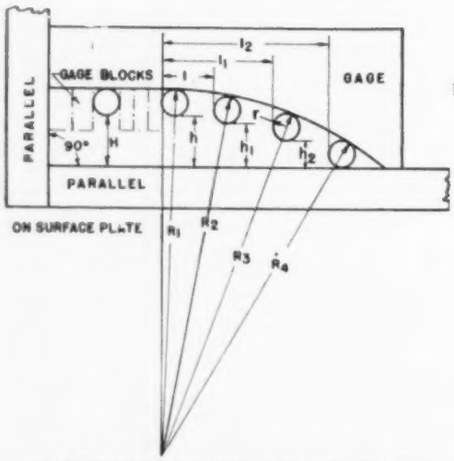


Fig. 2

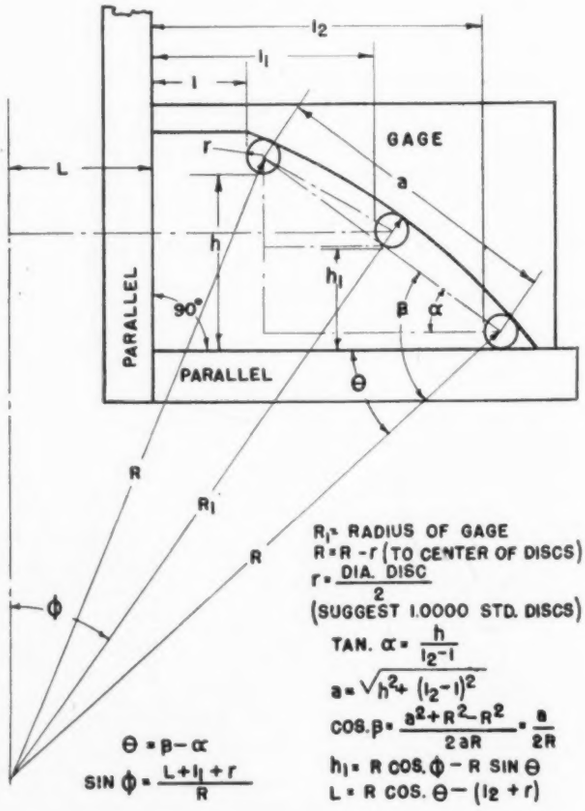


Fig. 3

MEASURING PROFILE GAGE—FLAT SHEET TYPE

r = RADIUS OF MEASURING DISC. (SUGGEST 1.0000 DIA STD.)
MEASUREMENTS H, h, h_1, h_2,
l, l_1, l_2 FOUND WITH PRECISION GAGE BLOCKS.

$R_1 = \frac{(2r)^2 + 4(H-h)^2}{8(H-h)} + r$

$R_2 = \frac{(2(l+r))^2 + 4(H-h_1)^2}{8(H-h_1)} + r$

$R_3 = \frac{(2(l_1+r))^2 + 4(H-h_2)^2}{8(H-h_2)} + r$

$R_4 = \frac{(2(l_2+r))^2 + 4H^2}{8H} + r$

IF GAGE IS CORRECT ALL R_3 WILL BE ALIKE

R_1 = RADIUS OF GAGE
$R = R - r$ (TO CENTER OF DISCS)
$r = \frac{\text{DIA. DISC}}{2}$
(SUGGEST 1.0000 STD. DISCS)

TAN. $\alpha = \frac{h}{l_2 - l}$

$a = \sqrt{h^2 + (l_2 - l)^2}$

$\cos \beta = \frac{a^2 + R^2 - R^2}{2aR} = \frac{a}{2R}$

$h_1 = R \cos \phi - R \sin \theta$

$L = R \cos \theta - (l_2 + r)$

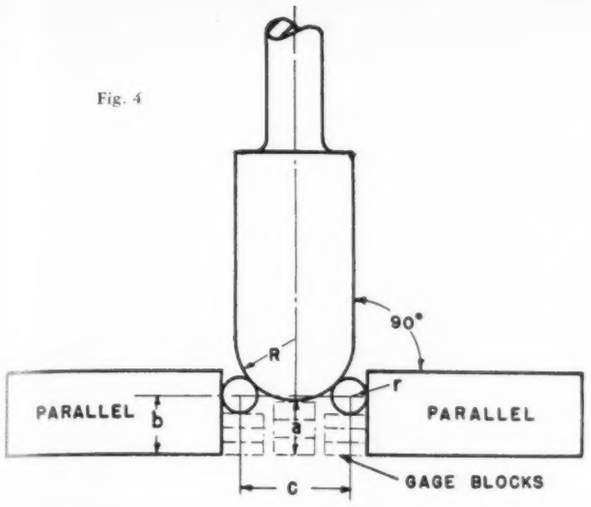
$\theta = \beta - \alpha$

$\sin \phi = \frac{L + l_1 + r}{R}$

MEASURING PROFILE GAGE—FLAT SHEET TYPE WITH RADIUS STRUCK FROM POINT AWAY FROM GAGE

ANY NUMBER OF MEASUREMENTS MAY BE TAKEN USING THE ABOVE FORMULAS

Fig. 4



MEASURING PROFILE PLUG GAGE WITH ROUNDED END

R = RADIUS ON GAGE
r = RADIUS OF ROLL

$$R = \frac{c^2 + 4(b+r-a)}{8(b+r-a)} - r$$

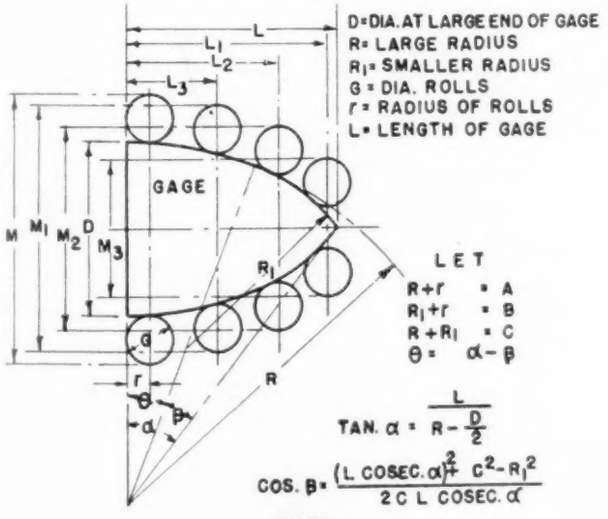
Full Contour Gages*

Full contour gages include profile plugs, receiver, and chamber gages. These gages perform essentially a three dimensional inspection of the component part. They are employed when the surface parts to be inspected are intended to mate with the surfaces of other parts. An entire surface is inspected at one time. As in the case of the template, a "go" gage only is used and a check piece is supplied to ascertain that the gage is correct. The gage shown in Fig. 1 is being used to inspect a die employed in manufacture of a shell casing.

Inspection

Inspection of profile gages presents some of the most engrossing problems in gage inspection. In general the problem will be one mathematical nature. Inspection will

*Not Standard Army Nomenclature



$$\text{TAN. } \alpha = \frac{L}{R - \frac{D}{2}}$$

$$\text{COS. } \beta = \frac{(L \text{ COSEC. } \alpha)^2 + C^2 - R_1^2}{2\,C\,L \text{ COSEC. } \alpha}$$

THEN

$$M = D + 2G - 2\left(A - \sqrt{A^2 - r^2}\right)$$

$$M_1 = D + 2G - 2\left(A - \sqrt{A^2 - L_3^2}\right)$$

BE SURE L_3 IS NOT BEYOND POINT OF TANGENCY OF R AND R_1

$$M_2 = D + 2G - 2\left[A - \left(\sqrt{B^2 - (L_2 - C \text{ SIN. } \theta)^2} + C \text{ COS. } \theta\right)\right]$$

BE SURE L_2 IS BEYOND POINT OF TANGENCY OF R AND R_1

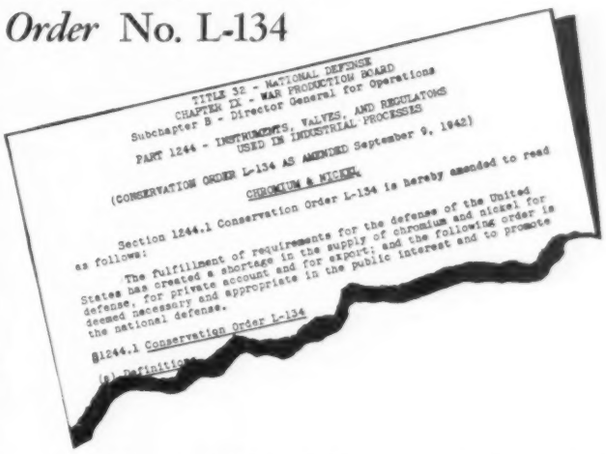
$$M_3 = D + 2G - 2\left[A - \left(\sqrt{B^2 - (L_1 - C \text{ SIN. } \theta)^2} + C \text{ COS. } \theta\right)\right]$$

MEASURING BULLET PROFILE CHECK GAGE

Fig. 5

How to **CONSERVE** *Essential* **INSTRUMENT MATERIALS**

in compliance with WPB *Conservation Order* No. L-134


TITLE 32 - NATIONAL DEFENSE
CHAPTER IX - WAR PRODUCTION BOARD
Subchapter B - Director General for Operations
PART 1244 - INSTRUMENTS, VALVES, AND REGULATORS USED IN INDUSTRIAL PROCESSES
(CONSERVATION ORDER L-134 AS AMENDED September 9, 1942)
CHROMIUM & NICKEL
Section 1244.1 Conservation Order L-134 is hereby amended to read as follows:
The fulfillment of requirements for the defense of the United States has created a shortage in the supply of chromium and nickel for defense, for private account and for export; and the following order is deemed necessary and appropriate in the public interest and to promote the national defense.
§1244.1 Conservation Order L-134

Many valuable solutions to problems arising from the new WPB Conservation Order L-134, which drastically limits the use of various materials for thermocouples, lead wire, thermometer bulbs, protecting tubes, etc., are given in the recently published Wheelco Supplement to Thermocouple Bulletin S2-3. The Supplement S2-3 is the result of an extensive analysis of the WPB Order L-134 by Wheelco Engineers and is published for the benefit of those who will be affected by this order. The Supplement also contains a partial summary of the L-134 Order; the complete L-134 Order as amended September 9, 1942, additions and revisions applying to various items in the Wheelco S2-3 Bulletin and a complete list of Wheelco Sales and Service Engineers who can help you with your instrument problems.

Write for your FREE copy of Supplement to Bulletin S2-3 and the issue of Wheelco Comments which deals with Thermocouple construction and maintenance.

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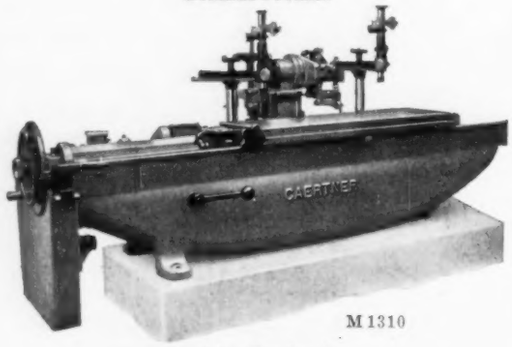

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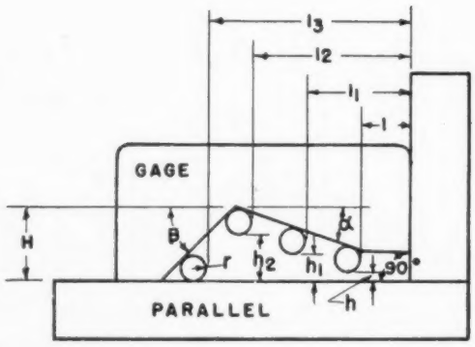


Fig. 6

MEASURING ANGULAR PROFILE GAGE HAVING TWO ANGLES

r = RADIUS OF MEASURING ROLL
DIMENSIONS l, l_1, l_2, l_3, h, h_1, & h_2
FOUND WITH PRECISION BLOCKS

$$\text{TAN. } \alpha = \frac{h_2 - h}{l_2 - l}$$

$$\text{ALSO TAN. } \alpha = \frac{h_1 - h}{l_1 - l}$$

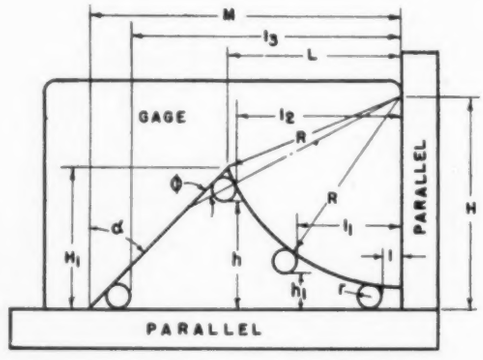
$$\text{TAN. } \beta = \frac{h_2}{l_3 - l_2}$$

$$\phi = \frac{180° - (\beta + \alpha)}{2}$$

$$H = \left(r \text{ COT. } \phi + r \text{ COT. } \frac{\beta}{2} + \frac{h_2}{\text{SIN. } \beta}\right) \text{SIN. } \beta$$

involve either surface plate or contour comparator work. If contour comparator is used, the inspection will usually require drawing of the profile to an enlarged scale. This is mounted on the screen of the comparator and the profile of the part is compared with this drawing.

Figs. 1 to 7 are drawings of typical surface plate set-ups for inspection of profile, template and full contour gages.



MEASURING PROFILE GAGE COMBINING ANGLE AND RADIUS

r = RADIUS OF MEASURING DISC
H = HEIGHT FROM WHICH RADIUS IS STRUCK
R = RADIUS ON GAGE — SEE PLATE 47 FOR FORMULA
H_1 = HEIGHT OF INTERSECTION ANGLE & RADIUS
(ALL OTHER DIMENSIONS FOUND WITH PRECISION GAGE BLOCKS)

$$\text{TAN. } \alpha = \frac{l_3 - l_2}{h}$$

$$M = r \text{ COT. } \frac{90° - \alpha}{2} + r + l_3$$

$$r \text{ COT. } \frac{90° - \alpha}{2} + r + l_3 - H_1 \text{ TAN. } \alpha = L$$

$$\sqrt{(R+r)^2 - (l_2 + r)^2} = H - (h + r)$$

$$\sqrt{(R+r)^2 - (l_1 + r)^2} = H - (h_1 + r)$$

$$\sqrt{(R+r)^2 - (l+r)^2} = H - r$$

$$\sqrt{R^2 - (H - H_1)^2} = L$$

Fig. 7

Amended Notice
FINAL—
Only a few
days left

Calling All Readers with Ideas on Speeding War Work

(even old ideas—*especially* old ideas now producing results that should be better known)

IF you love America—and of course you do—it is your duty to do all you can to help America's mighty war industry grow mightier . . . fast! True, you are already going all out on your own job: at every month's end, you know you've done a good month's work to axe the Axis. (You've probably done what was two months' work before Pearl Harbor!) But perhaps you can make a suggestion that will save thousands of work-months. Yes, you, the typical reader: most useful suggestions don't come from a few geniuses but from the many wide-awake workers—each alert to see some "tremendous trifle" that had previously escaped notice. Especially is this true now. Especially is this true with regard to the use of instruments. And that's where you shine! One big bottleneck is that millions of inspectors and testers still have to rely on their hands, their eyes, their judgment subject to fatigue. Yes, here in America, where automatic gadgets have been invented, each doing the work of twenty or two hundred humans and doing it better! The pity of it is that there is no need for this bottleneck—because every type of test or determination is being done automatically somewhere. The few basic inventions have all been made; what's needed is ten thousand adaptations or applications—such as you have in mind right now . . . or such as you have already installed. (Don't be too modest: that "unimportant" automatic method over in the corner of the second floor of Building R-73 may not have been brought to the attention of the thousands who should know about it.) And there are some other bottlenecks in production that can be eliminated by the use of automatic instruments.

NOTE—In lots of places the inspectors and the management are so proud of "doing it in half the former time" that they can't imagine any further improvement *(but it could be done in one-hundredth the former time)*. In some cases there is a belief that the Army or Navy "wants it done just that way" *(but the spirit of A&N specs is results, not methods, and the higher officers want faster methods—provided that quality is not impaired but bettered)*. In many instances the only ban on automaticity is that the product to be tested or measured or controlled automatically or continuously is "different" *(but the instrumental function to be performed is exactly the same!)*.

YOU ARE INVITED, therefore, to send in your suggestion (or suggestions) for publication in the big January Special Issue of *Instruments*. The rules are simple:

1. Everyone is invited.
(On some previous occasions we excluded persons in the employ of instrument companies. Not this time! If you have worked out a new labor-saving application of any device, don't hold back because you happen to be selling that device. If one of your customers has worked it out, have him write it up; and if he is too busy or too modest, write it up for him.)

2. Contribution should be typewritten, double-space, on one side of 8½ × 11 (or 8 × 10½) paper. Name and address of author typed at top of first page; name at top of other pages.

3. Diagrams should be in black ink on white paper (or tracing cloth or paper). No blueprints. Name and address of author on each diagram. *Good* photographs will be accepted.

4. Each contribution to describe the solution of ONE specific problem. Each author, however, may send as many as he wishes.

4a. Cash paid for descriptions published. See page 513.

5. Be brief, but don't omit descriptive details.
(If you describe the continuous automatic measurement of something usually measured intermittently by hand, don't write a book about the theory of automatic continuous measurements. On the other hand, don't send in something like this: "We have an automatic tester for length, weight, hardness and profile of A-P cores that replaces twelve girls." That is too brief!)

6. A solution need not be an instrument: it can be a fixture, a conveyor, or any set-up that *makes possible or practicable** the use of an automatic instrument.

7. Write it up TODAY then put it away; a few days later, read it with a fresh mind and add any essentials you might have overlooked. All contributions must be on your editor's desk in Pittsburgh by DECEMBER 31.

NOTE
Postponed
Closing
Date

8. Owing to the large volume of mail received at this office, it is essential that all articles written in response to this invitation be addressed to: **War Work Speed-up Editor, The Instruments Publishing Co., 1117 Wolfendale St., Pittsburgh, Pa.**

*For years I've been advocating the full-automatic or conveyorized inspection of artillery ammunition but always was told that although it is **possible** it is **impracticable** because moving heavy projectiles (above .50-cal.) wear down fixed gaging anvils or vees in hours or even minutes; because the elaborate hydraulic mechanisms for speedily shifting and then gently lowering the shells would take too many man-years to design, develop and test; and because they would require more man-years to manufacture in adequate ranges of sizes and models than would be saved. I was told that a typical installation would cost $25,000. Well, I'd like to see what **you** can do with shock absorbers now available by the millions in auto graveyards, plus a simple gravity-roll feed: maybe your installation (exclusive of the automatic electric or pneumatic gage and relay for tripping rejects) would cost nearer $25 than $25,000.—M. F. BEHAR, Editor, Instruments.

Gauging Flow Meter

Suppose you had the time to set up an ideal specification for a flowmeter. Naturally your first consideration would be accuracy. Here is a standard for gauging meter accuracy. This standard is the ratio of power to friction.

Let's Consider an IDEAL FLOW METER

We would look for 4 POINTS

- HIGH ACCURACY
- LOW MAINTENANCE,
- READABILITY, and
- ADAPTABILITY TO VARYING CONDITIONS

1. Accuracy is the No. 1 consideration.

MOST METERS MEASURE FLOW THRU THE VELOCITY HEAD

Produced by

ACCURACY DEPENDS ON HOW WELL THIS U HEAD IS TRANSLATED TO THE

and

2. Accuracy depends on what's between the orifice and the chart.

IN ALL METERS...

FRICTION MUST BE OVERCOME

POWER MUST BE DELIVERED TO PEN

HIGH ACCURACY = $\frac{\text{POWER}}{\text{FRICTION}}$

3. Here then is the basic standard... $\frac{\text{POWER}}{\text{Friction}}$

The COCHRANE METER

... Approaches This Ideal

Lets See How!

7. Well, let's see how we do it.

COCHRANE *Friction Free* FLOW METER

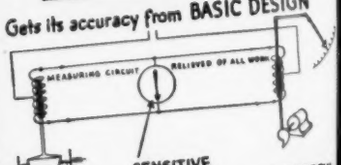
STARTS with a FRICTIONLESS TRANSMITTER

ENDS with HIGH and EQUAL POWER AT PEN THRUOUT SCALE

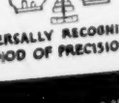
8. Exactly as the ideal requires, the motor supplies high power from 0-100%...

COCHRANE *Friction Free* FLOW METER

Gets its accuracy from BASIC DESIGN



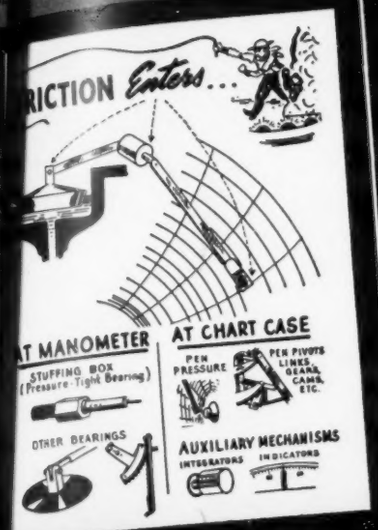
In Accordance with The NULL Method



UNIVERSALLY RECOGNIZED AS THE METHOD OF PRECISION MEASUREM

9. because in this NULL syste the circuit does no work.

Accuracy

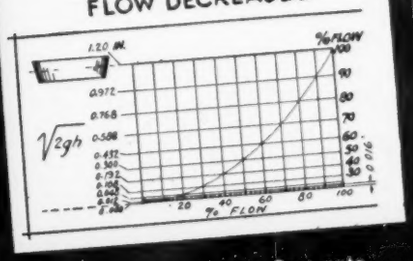


4. No meter is without friction—and some have considerable.

IN MOST METERS
POWER
COMES FROM A FLOAT

WHICH MOVES ONLY AFTER BUOYANCY
OVERCOMES FRICTION

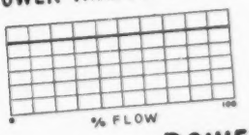
BUT FLOAT MOVEMENT BECOMES SMALLER AS FLOW DECREASES



5. And the lower the flow rate the smaller the power ($\sqrt{2gh}$)

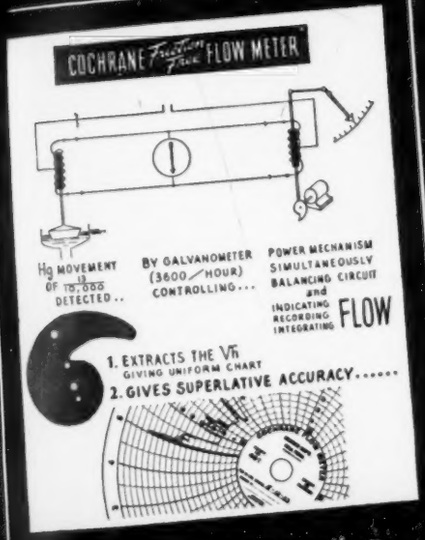
In the *Ideal* METER
MANOMETER FRICTION IS ELIMINATED

CHART (CASE) FRICTION IS DWARFED BY HIGH AND EQUAL POWER THRUOUT SCALE



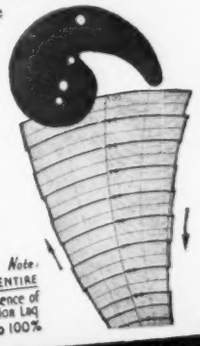
Remember HIGH ACCURACY = **POWER** / FRICTION

6. Note well we want high and equal power from 0 to 100% flow.

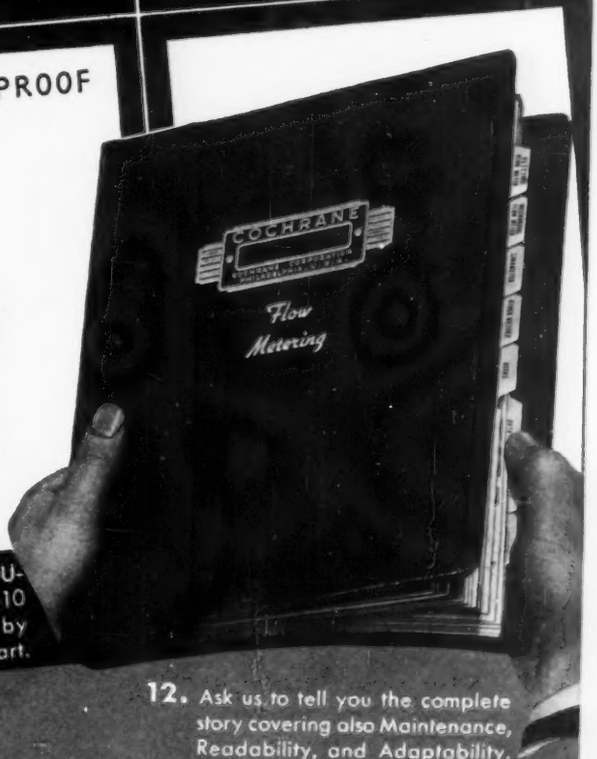

COCHRANE Friction Free FLOW METER
Hg MOVEMENT of 1/2,000 DETECTED..
BY GALVANOMETER (3600/HOUR) CONTROLLING...
POWER MECHANISM SIMULTANEOUSLY BALANCING CIRCUIT and INDICATING RECORDING INTEGRATING
FLOW
1. EXTRACTS THE $\sqrt{h}$ GIVING UNIFORM CHART
2. GIVES SUPERLATIVE ACCURACY.....

10. The cam produces a uniform chart AND superlative accuracy because . . .

AND AS VISIBLE PROOF
EACH Cam Shaped to exactly record water column differential thruout scale



11. each cam is INDIVIDUALLY calibrated at 10 test points as shown by the final record chart.



12. Ask us to tell you the complete story covering also Maintenance, Readability, and Adaptability.

COCHRANE

3100 N. 17th STREET PHILADELPHIA, PA.

"DANGER SPOTTERS"

A RED LIGHT winked out of the darkness! The pilot snapped to attention and checked his instruments for trouble . . . port engine fuel pressure dangerously low!

Instantly, he worked with the emergency hand wobble-pump, brought the pressure back to normal—and managed to keep it there until he reached destination.

The above incident, which actually happened over the mid-Atlantic on the ferry trip of a bomber bound for Britain, illustrates the importance of Pressure Warning Units to the pilot.

As you know, these little "danger spotters," weighing less than 6 ounces, free his eyes from constant instrument checking—for rest, for reconnaissance or combat operations . . . yet give instant warning of falling fuel or oil pressure in any engine before it becomes serious.

The Pressure Warning Unit is one of many devices and precision instruments which Kollsman makes for the Army and Navy, instruments that make our military aircraft safer and more efficient in flight.

KOLLSMAN
AIRCRAFT INSTRUMENTS
Product of
SQUARE D COMPANY
ELMHURST, NEW YORK • GLENDALE, CALIF.

APPLICATIONS OPERATING PRINCIPLES INSTALLATION MAINTENANCE

Aviation Instruments

Navigation Automatic-piloting Power plant Automatic-landing Aerological
Communication Flight-testing Production Instrument-testing

Vol. I, No. 7 GUEST EDITOR: W. J. WATKINS December 1942

THE INSTRUMENT TECHNICIAN

His Growing Importance in All Divisions of Aviation

Editorial by **W. J. WATKINS**, *Guest Editor*,
Chief Instructor, American School of Aircraft Instruments, Glendale, Calif.

Who He Is and What He Does

THE instrument technician has been called "the man behind the man at the controls." This is no mere romantic description. It is a fact that the pilot's mind can be at ease about the safe, efficient operation of the ship. The pilot knows that the instruments are telling the exact truth. He knows that they have been pronounced in perfect operating condition by an expert—the instrument technician.

Behind the man at the controls there are, in fact, many instrument men. They have first carried out the design, precision manufacture, and scientific testing of instruments, then installed them, and again checked the instruments and pronounced them ready for their first service in the air—and later inspected, repaired, and overhauled these vital aids to flight.

William J. Watkins is a leading national authority on training in aircraft instrument maintenance who pioneered the preparation of aircraft instrument textbooks and the development of shop training methods. He came to the field of aircraft instruments with a broad background of mechanical, electrical and technical experience. When he first became associated with Herbert W. Hartley in the operation of the American School of Aircraft Instruments, the field of instruction in instrument maintenance was in its early stages. Instrument work was commonplace in airline maintenance operations, of course, but the importance of instruments was increasing by leaps and bounds and there were comparatively few men who possessed organized practical training. Mr. Watkins attacked this problem and found his first hurdle to be the lack of text material suitable for instructing men who possessed little or no previous knowledge of aircraft instruments. He gathered together all available material from governmental sources and instrument manufacturers and carried out extensive personal research. The result was a complete set of lesson texts covering all phases of maintenance of instruments, replete with illustrations and diagrams explaining the text and picturing specific operations. This material has undergone constant revision and amplification in line with progress in aircraft instrumentation. Equally important has been Mr. Watkins' development of shop training equipment and methods. Guided by practically no precedents, he has succeeded in duplicating actual instrument maintenance conditions, equipment and procedure as existing in actual instrument shops, such as those of the airlines. He has been responsible for a large number of distinct advances in the development of instrument testing devices. Many instrument mechanics and technicians in all branches of aviation have been trained under his direction, so that the benefits of his work in this field have become widespread in the industry.

Instrument Progress Revolves Around the Instrument Man

The instrument technician is in the midst of instrument development and improvement. If with an instrument manufacturer, he is at the very starting point. If with an aircraft builder, he can observe the suitability of design for quick installation and efficient operation. If in an airline instrument maintenance department, or in Civil Service at an Army or Navy aircraft maintenance depot, he grows intimately familiar with construction and operation.

The instrument technician is not only of ever-mounting importance because the continued, and even greater, safety of flying depend on his expert craftsmanship, but also because he is the man best qualified to point out and create improvements in instruments. This is both a stirring challenge and a magnificent opportunity for the man considering entering instrument work.

Now Even More Important in Military Aviation

Playing a part in peace-time progress is still ahead for the instrument man—but his most vital role NOW is the great contribution he makes to our success in the air. On his highly specialized skill and knowledge depends the effective operation of all our fighting planes, as well as the swift return to the air of many. Whether employed by the instrument manufacturer, aircraft builder, in Civil Service, or in direct Army or Navy aircraft maintenance, he is on our first line of defense.

The Past Foretells the Future

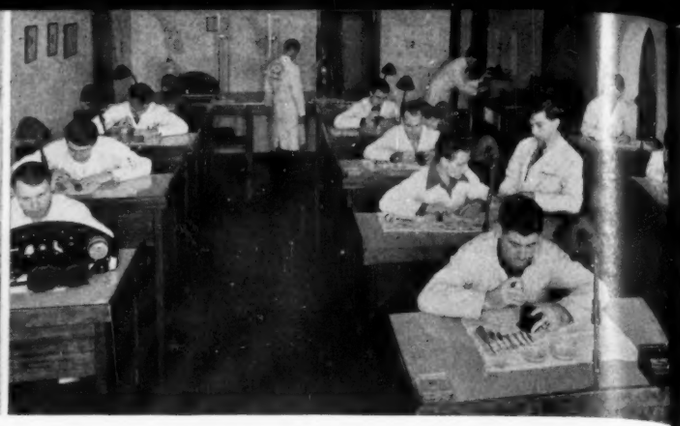
Throughout the history of aviation there has been an ever-swelling crescendo of the cry "More planes, more planes." The *fun* of flying has steadily increased the demand for private planes, while the *business* of flying has required ever-mounting numbers of transport planes. At the same time the number of hours in the air, for each pilot and for each plane, has increased tremendously.

Meanwhile the *necessity* of flight in military operations created huge air forces. Production of fighting planes for friendly nations, and for our own preparedness program, reached huge proportions which, under the dictates of actual conflict, were quickly surpassed. For wartime combat, for peacetime preparedness, our leaders plan for our country "an air force second to none."

Today's aviation statistics dwarf to insignificance the figures of only a decade and less ago. Even so, authorities agree that the airplane is in the stage of public use similar to the automobile's early days . . . that the world will be a vast network of airlanes over which will travel virtual flying freight and passenger trains . . . that military power

(Continued on Page 524)

PRIMARY Pressure Instrument Shop



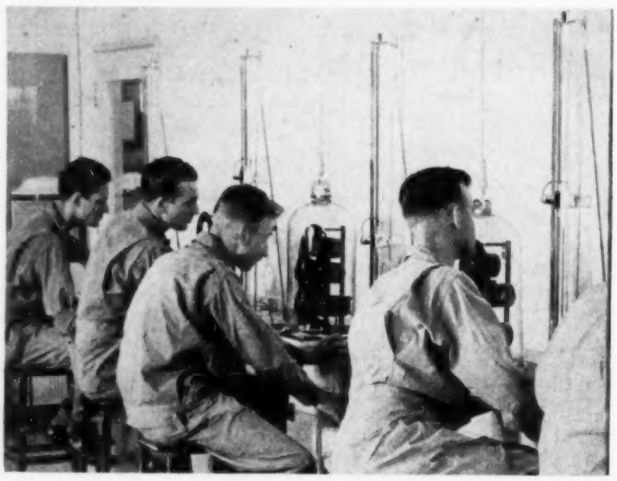
ADVANCED Pressure Instrument Shop

Two of the CIVILIAN Shops, American School of Aircraft Instruments

Training Military and Civilian Personnel as Aircraft Instrument Technicians

By W. J. WATKINS
Chief Instructor, American School of Aircraft Instruments

FOR several years before December 7, 1941, American School of Aircraft Instruments had been training civilians for placement in airlines, Civil Service shops and private instrument repair shops. During these years, American School of Aircraft Instruments had grown from a small school to the largest specialist school on aircraft instruments in the United States. In fact, for many years, it was the only instrument specialist school in the country.



Enlisted Men Testing Pressure Instruments After Overhaul, U. S. Army Air Forces Technical Training Detachment, A.S.A.I.

During those years of development, there were many problems to be solved, such as lack of text material, course of study, etc. As is always the case in pioneering, we had to solve these problems for ourselves. By compiling all available material from the manufacturers and augmenting it with theoretical explanations, as well as by securing first-hand information of service problems from the airlines, we were able to create a satisfactory text. By trial and error with various systems of training, we finally arrived at a course of study which proved satisfactory for the training of instrument mechanics for the airlines and Civil Service bases.

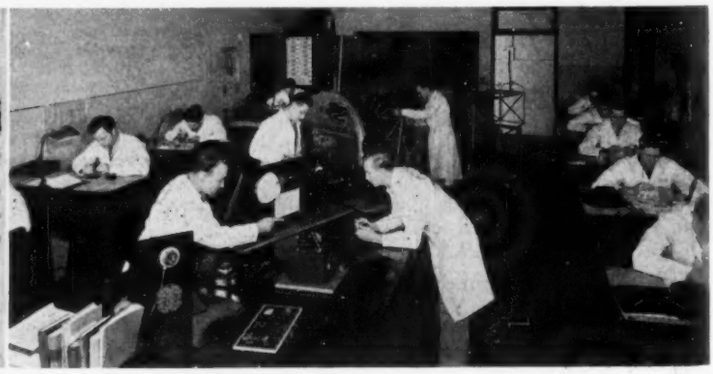
This course of training covers the complete field of aircraft instruments, both in theory and shop practice. The student progresses through the primary pressure instrument shop, the advanced pressure instrument shop, the electrical instrument shop and the gyro instrument shop.

It takes six months to complete this course of study, after which a student is fully qualified to enter the field of aircraft instruments. In fact, this six-month course is accepted in lieu of two year of experience in applying for the position of Junior Instrument Mechanic positions on Civil Service.

After December 7, 1941, the Army became interested in the training of enlisted men in this specialized work. Upon checking with airlines, Civil Service bases and instrument manufacturers, it was decided that American School of Aircraft Instruments was the logical place for such training. However, it was their desire to have these men trained as specialists in only one phase of instrument work. This did not present any serious problem as we already had our

(Continued on Page 540)

Army Enlisted Men Testing Electrical Instruments After Overhaul.



A Corner of the Electrical Instrument Shop, Civilian Quarters.

Military and Civilian ELECTRICAL Instrument Training, A.S.A.I.

Overhaul Procedure—Pendulum Assembly of Horizon and Bank & Climb Unit

By ROBERT BEN KEES

Chief Civilian Gyro Instrument Instructor, American School of Aircraft Instruments

BECAUSE of lack of information on the overhaul of the pendulum assembly, gyro mechanics sometimes encounter trouble with this operation. After considerable experimenting, the following system of overhaul has been adapted as standard at the American School of Aircraft Instruments. If each step of this procedure is followed *with the utmost care*, it is possible for any mechanic to make a good overhaul job on the pendulum assembly.

1. After the pendulum assembly has been removed from the rotor housing, clean the assembly by washing it in naptha and dry under air pressure.

2. Next, clean the assembly in a bath of jeweler's rejuvenator, agitating the assembly and working each pair of vanes back and forth several times.

3. Wash the assembly in clean warm water until all traces of rejuvenator have been removed and dry thoroughly under clean low-pressure air.

4. Insert the pendulum gage T 20594 through the elongated hole below the high shaft with the recessed side facing the beveled edge of the vane. If the vanes are at their right setting, the pendulum gage will just pass the beveled side of the vane on the opposite side. (Note: It has been found desirable to have the fore and aft vanes open about 40% while the side vanes are 50% open.)

(Continued on Page 540)

Training in GYROSCOPIC instruments, A.S.A.I.

***Top and Inset*—U. S. Army Air Forces Technical Training Detachment. *Bottom*—Advanced department of civilian quarters.**

Pressure Instrument Department, U. S. Army Air Forces Technical Training Command, American School of Aircraft Instruments.

An Improved Manometer Built of Plastics

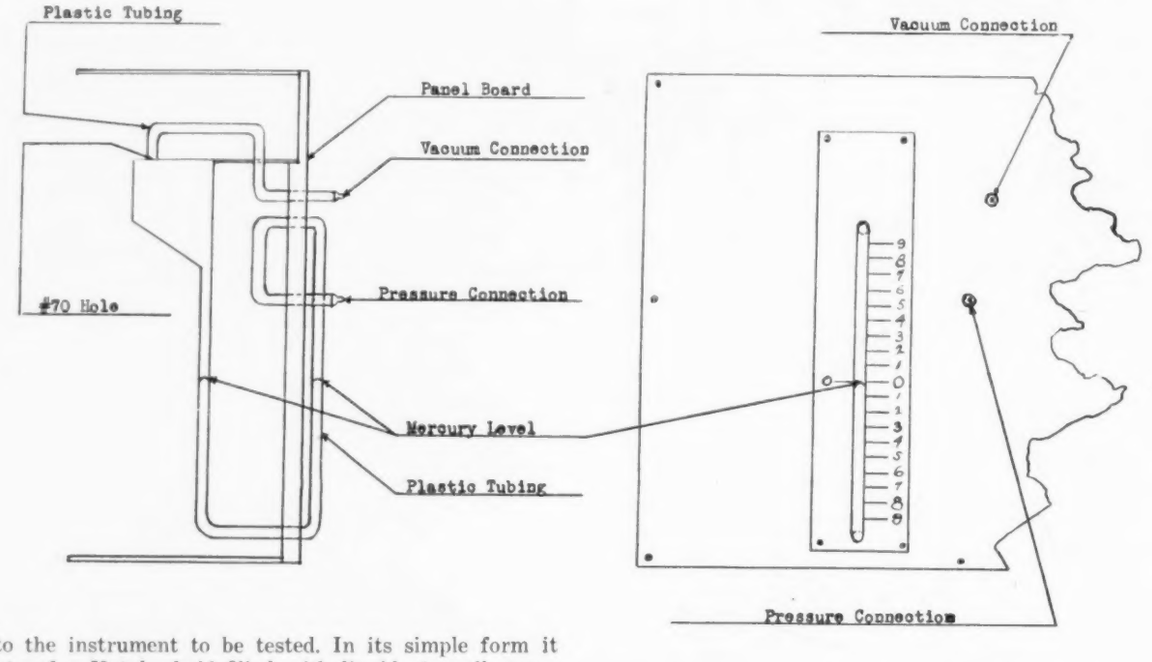
By JAMES STUART

Chief Army Instrument Instructor, American School of Aircraft Instruments

A NEW type of manometer has been designed for use in the Gyro shop at The American School of Aircraft Instruments. This new type of manometer is made entirely of plastics.

A manometer is an instrument to measure the differences in pressure from atmospheric; therefore one end of the manometer is open to atmospheric pressure and the other end to the instrument to be tested. In its simple form it consists of a U tube half filled with liquid, (usually mercury). On one leg of the U tube, a trap or surge chamber has been designed to prevent the loss of mercury. This surge chamber is an enlarged part of the U tube, with sufficient capacity to hold the total amount of mercury in the tube. If the pressure is considerably greater than atmospheric pressure, usually caused by a pinched line, this surge chamber will prevent the loss of mercury by allowing the mercury to enter the expanded portion of the U tube; therefore the pressure or vacuum will pass around the mercury.

The surge chamber or trap is made of clear Lucite 1½" in diameter and 2" long. This is closed at both ends with Lucite sheeting cut to size. The bottom of the trap tapers toward the U tube; therefore the mercury will run back into the U tube. This trap is welded together with chloroform. On the top of the trap a connection is welded, with a No. 70 drill opening. In the vacuum manometer the hose leading to the instrument is connected here. In the pressure manometer the opposite leg of the U tube is connected to the instrument. The U tube is made of clear Tenite ½" in diameter and 24" long. This can be formed into the U shape by placing it in warm water and bending. The U tube is then welded to the trap with chloroform. Only one leg of the manometer is seen by the mechanic, the other being behind the panel as the diagram shows. The scale is made of Lucite sheeting cut to size and graduated in inches of mercury.

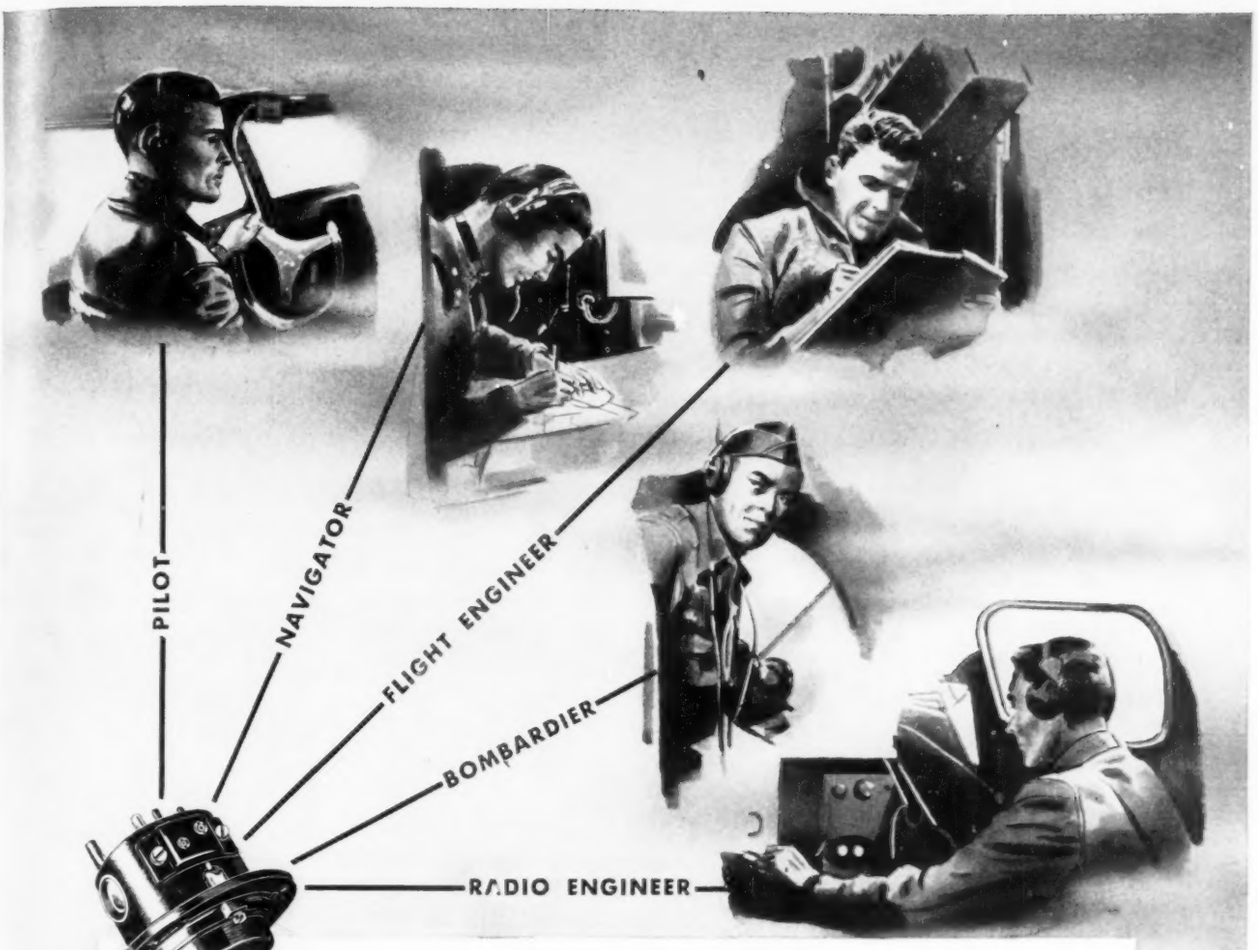


The Instrument Technician—His Growing Importance

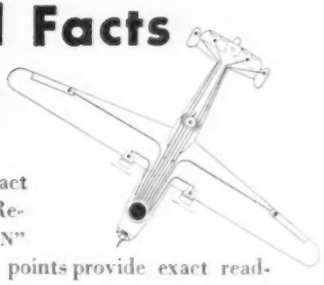
(Continued from Page 521)

will consist almost solely of mammoth air forces. Undoubtedly, these countless and mounting thousands of planes will proportionately multiply the number of instruments in service. More than that—because *more* instruments per plane will be required for the bigger aircraft of the future, for regularly scheduled flight regardless of weather conditions, for longer flights, and because of more instrument flying by private flyers.

It is not only more planes and more instruments, but also greater use of all types of aircraft, that makes instrument maintenance an evergrowing, *permanent* division of America's Greater Aviation.



Giving them Vital Facts by *Remote Indication*



SWIFT, intelligent action on the part of a combat plane's crew must be based on facts accurately determined and quickly conveyed. Obtaining and transmitting such information...from many vital points throughout the plane...is the important job entrusted to the "PIONEER AUTOSYN" System.

Incorporated in precision instruments in tail, flaps, landing gear, engines, fuel tanks and other parts of the plane, are "PIONEER" Transmitter "AUTOSYN" units like the one illustrated. These small, ingenious mechanisms transmit exact measurements. Receiving "AUTOSYN" units at desired points provide exact readings. The whole system operates through low voltage wiring, eliminates long shafts and heavy, cumbersome tubing carrying dangerous liquids or fumes.

"PIONEER" Flight, Navigation and Engine Instruments are designed and built by men and women whose single aim is to give our flyers the finest equipment obtainable.

Precision aircraft instruments of the Pioneer Instrument Division are important members of "The Invisible Crew," which includes the equipment and controls built by 25 Bendix plants from coast to coast and serving with our fighting crews on every front.

THE INVISIBLE CREW
Precision Equipment by Bendix
AVIATION CORPORATION

PIONEER INSTRUMENT DIVISION

Electrical Instrument Department, U. S. Army Air Forces Technical Training Command, American School of Aircraft Instruments

An Electrical Instrument Test Panel

By HAROLD L. HAMM

Chief Instructor of Army Electrical Instrument Department, American School of Aircraft Instruments

IN these days of shortages, priorities and poor shipping conditions, many an instrument repair man has had to tax his ingenuity to the utmost. In order to have adequate test equipment, single test instruments must be calibrated to cover many ranges. These must also be accurate and readily adaptable to a quick change from one aircraft instrument to another.

In order to meet these demands, the instrument described was developed in our electrical shop. It has replaced several pieces of more costly and elaborate test equipment, and has been found to do the job just as quickly and efficiently.

This instrument is a test panel measuring microamps, milliamps and millivolts, obtaining its power from a 12-volt storage battery. This power is uniformly controlled by two potentiometers, one for voltage and the other for current. The potentiometers are made of a high-quality wire giving smooth even control throughout the range.

The test panel is simple in construction, the materials needed being one dural or aluminum panel, one #301 type Weston instrument having a range of 200 microamps, and an internal resistance of 53 ohms. Resistors of manganin wire are used because of their extremely low temperature coefficient of less than 0.00001 ohms. They are wound on Bakelite spools on the back of the panel. Any good two-bank selector switch of twelve contacts may be used, being sure that it is of rugged construction, with good wiping contacts of low resistance.

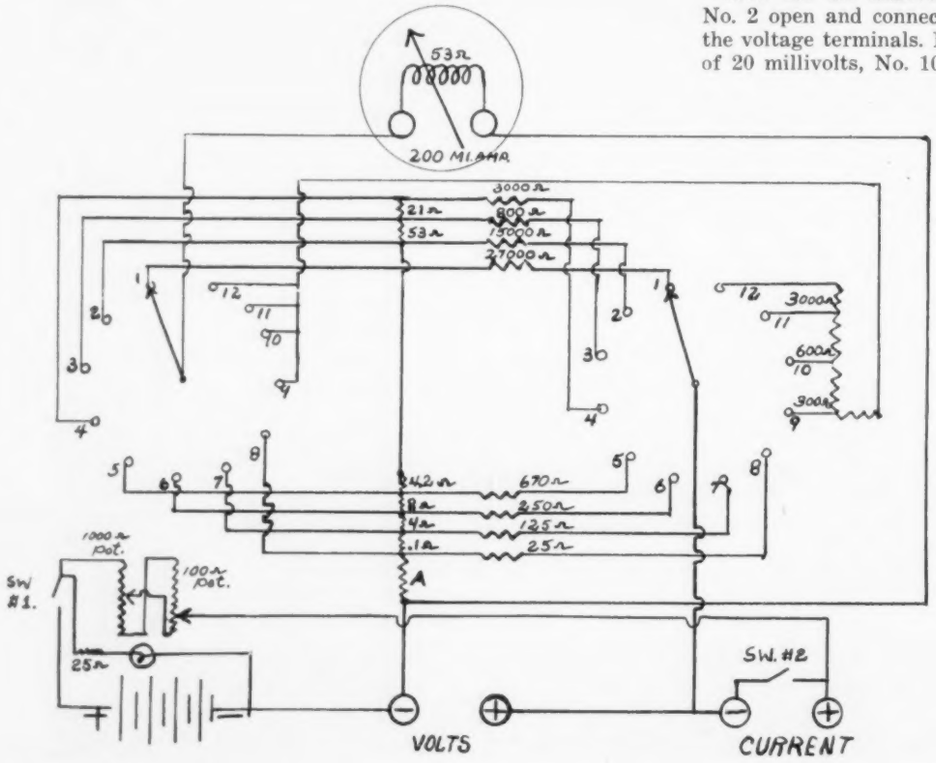
The use of separate pin jack contacts for the current and voltage outputs requires the use of only one toggle switch to change from current to voltage, using this switch to short out the current terminals when only the millivolt contacts are being used.

A unique feature of this panel is the use of voltage-limiting resistors in series with the microammeter to prevent high voltage from being accidentally connected across the contacts of the microammeter when the selector switch is on one of the low-current ranges. The twelve ranges, as given on the selector switch, are brought into use in most cases by an even multiple of the original range of 200 microamps. Position number 1 is a direct connection from the current terminals to the terminals of the microammeter itself. With each change of the selector switch, either shunts or multiplying resistors are brought into the circuit covering the following ranges: No. 1, 200 microamps; No. 2, 400 microamps; No. 3, 800 microamps; No. 4, 2 milliamps; No. 5, 8 milliamps; No. 6, 20 milliamps; No. 7, 80 milliamps; No. 8, 100 milliamps completing the current ranges.

Now for the millivolt ranges: Throw the toggle switch No. 2 open and connect the instrument to be tested across the voltage terminals. Position No. 9 gives us the low range of 20 millivolts, No. 10 cuts in another multiplier to bring the range up to 80 millivolts. Position No. 11, 200 millivolts and the last position, No. 12, 400 millivolts.

To make the check of any sensitive instrument, connect the terminals across the contacts corresponding to either a current or a potential type of indicator. Throw toggle switch No. 2 to a corresponding position, then with the voltage and current potentiometers turned to the off position, turn the toggle switch No. 1 to the power supply. Bring both voltage and current potentiometers to the on position until instrument to be tested reads full-scale, then make a note of the scale reading to determine the sensitivity of the instrument.

Resistor *A* in the test panel may be a small variable resistance under 5 ohms used to counteract any changes in the sensitivity of the indicator and may be adjusted accordingly.



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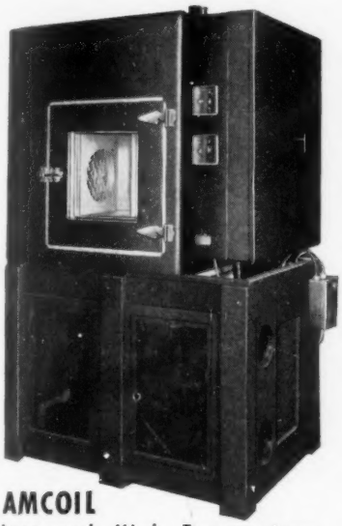
KNOW IN ADVANCE how instruments will perform under service conditions. Amcoil Chambers test accurately and automatically under extremes of cold and heat. In addition to the mechanical refrigeration and dry ice models illustrated, there are Amcoil Test Chambers for other uses, including humidity and altitude testing.

Information on these types as well as further details on those shown here will be furnished on request. Address Dept. I-12



AMCOIL

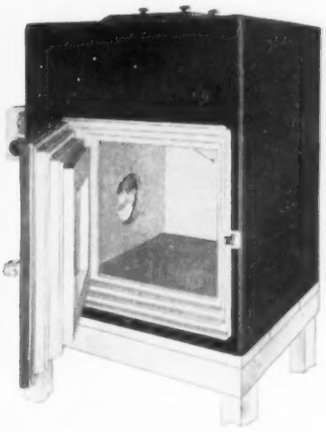
Low and High Temperature Test Chamber Model RTC3

- Mechanical Refrigeration (Quick Pull Down)
- Range: −55°C. to +70°C. (−67°F. to +160°F.)
- Exterior: 50" wide x 41" high x 36" deep, Stand: 34" high
- Usable interior: 27" wide x 19" high x 26" deep
- Interior Content: 7.7 cu. ft.

AMCOIL

Low and High Temperature Test Chamber Model RTC1

- Mechanical Refrigeration (Quick Pull Down)
- Range: −55°C. to +70°C. (−67°F. to +160°F.)
- Exterior: 71" wide x 56½" high x 42" deep, Stand, 35¾" high
- Usable interior: 59" wide x 28½" high x 39" deep
- Interior Content: 28.7 cu. ft.



AMCOIL

Low and High Temperature Test Chamber Model M50TC-1

- Dry Ice Refrigeration (Quick Pull Down)
- Range: −55°C. to +70°C. (−67°F. to +160°F.)
- Exterior: 40" wide x 43" high x 40" deep
- Usable interior: 21" wide x 21" high x 28" deep
- Interior Content: 7 cu. ft.

AMCOIL

Low and High Temperature Test Chamber Model RTC-1A

- Mechanical Refrigeration (Quick Pull Down)
- Range: −70°C. to +70°C. (−95°F. to +160°F.)
- Exterior: 71" wide x 56½" high x 42" deep
- Usable interior: 52" wide x 27½" high x 39" deep
- Interior Content: 25 cu. ft.

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SHOP KINKS

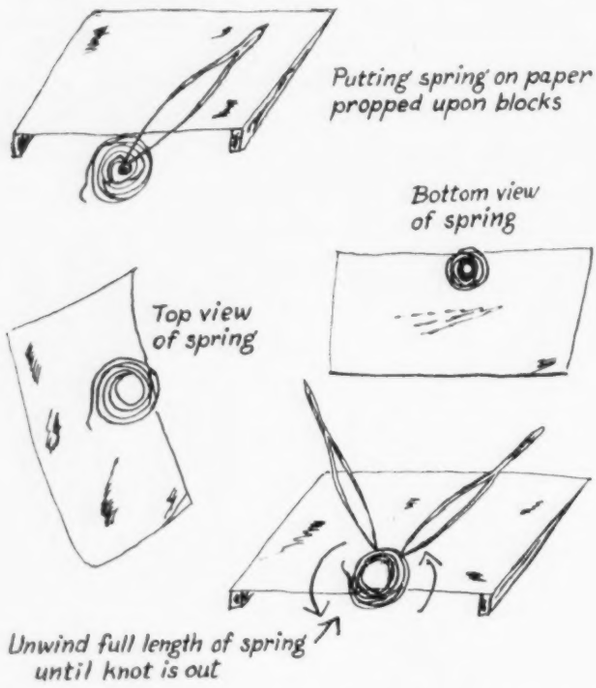
Untangling Hairsprings

By OTTO THRESS

Chief Army Pressure Instrument Instructor, A.S.A.I.

HOW many times have you gnashed your teeth and torn your hair at the sight of a very delicate hairspring tied in knots? Relax, chum, here is a gag that really will keep you from growing old.

Avail yourself of a piece of paper about the thickness of jeweler's rice paper, placing the paper at such an angle as


Putting spring on paper propped upon blocks
Bottom view of spring
Top view of spring
Unwind full length of spring until knot is out

to have approximately one inch of one edge an inch or so above the desk surface.

Remove hairspring from staff and place hairspring with collet down over the inclined edge of the rice paper in such a manner that the paper will be between the collet and first spring coil.

Very gently, so as not to distort the spring, revolve that entire portion of the spring on the top of the rice paper so as to cause the hairspring to crawl round by round to the underside of the paper. Continue this procedure until the first knot is on the edge ready to go to the underside. Now, with two pairs of tweezers, hold the spring coil in front of the knot stationary, and feed the loose end through the knot the same as you would untie a knot in a piece of cord. By following this procedure, any number of knots may be removed without the least hairspring distortion.

Try it and see how rosy the hairspring world will look.

Electrical Instrument Service Kinks

By O. F. HURST

Chief Civilian Electrical Instrument Instructor, A.S.A.I.

1. SOCKET WRENCHES THAT FIT IN STARRETT SCREW DRIVERS

IN servicing electrical instruments one finds that there are a number of small size nuts on the various instruments and that socket wrenches to fit them are hard to get (some sizes are impossible to get). Our needs for these wrenches were so great at the American School of Aircraft Instruments that we decided to make our own. After experimenting with a number of ways to make them, we finally decided to use size 0.010" drill rod for the shank and Allen set screws for the socket. We used the Allen set screws in the following sizes: 0.050, 1/16, 5/64, 3/32, 1/8, 5/32, 3/16 and 7/32. This gave a good variety of sizes that proved to be well worth making.

The 0.015 drill fits in the Starrett screw drivers. Cut the drill rod in 2" lengths and turn down one end of drill rod

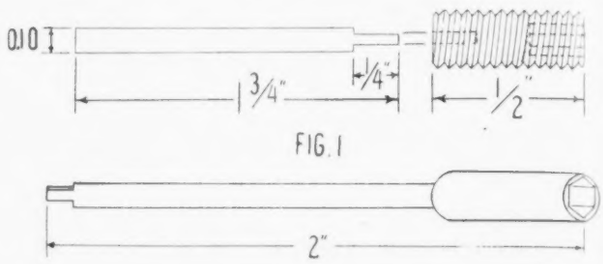


FIG. 1

in jeweler's lathe. See Fig. 1. Drill hole in Allen set screw to accommodate drill rod as also shown in Fig. 1.

Chuck drill rod in lathe, slip Allen set screw on rod, then bring tail stop up on lathe to hold the two firmly in place. After tinning the two with solder, sweat the two pieces together. We have found that solder will hold all the pressure that can be given when used in the Starrett screw drivers.

We found that the hexagons in the Allen set screws are not centered, so by centering in the lathe when soldering together, you get a well-centered socket wrench. With the set-up still in the lathe, use a cutting tool or a file on the smaller sizes and take the threads off the Allen screws to the point where no thread mark shows. As a final touch-up, use jeweler's rouge to polish.

2. JIG FOR MOVING COILS

Here is a simple and easy way to make jig to hold moving coils. This jig will accommodate all sizes.

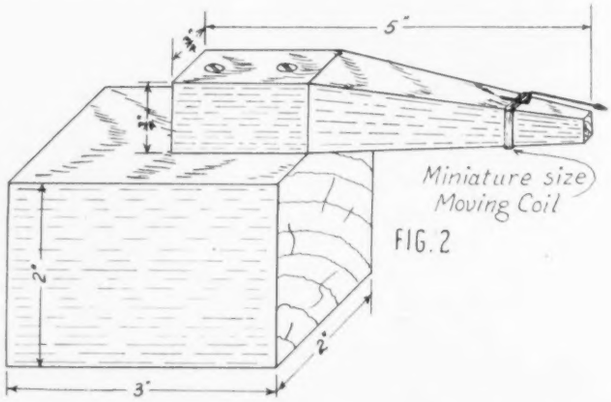


FIG. 2

Use a 2" × 2" piece of pine, 3" long for the base. (Fig. 2.) For the coil holder, use a 3/4" × 3/4" piece of pine, 5" long. Taper down to accommodate the smallest size moving coil that you are likely to encounter. Then screw down to base. Fig. 2.

How to Drill 'em Smooth and Round

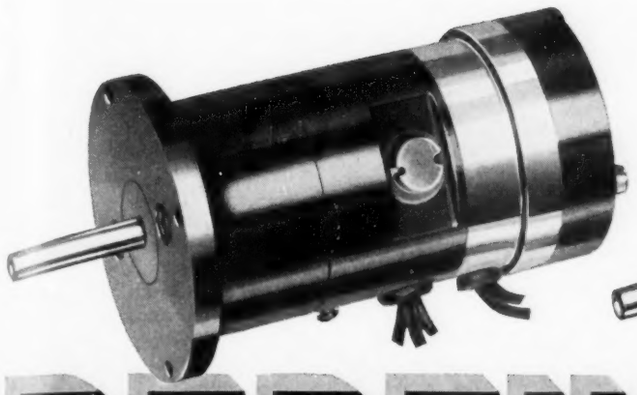
By CARROLL MOSER

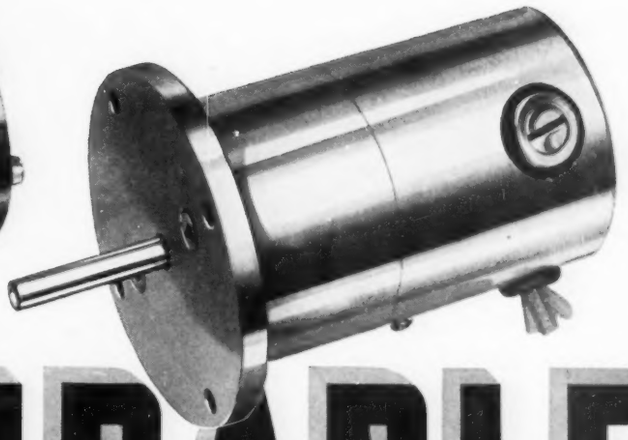
Army Pressure Instrument Instructor, A.S.A.I.

MUCH difficulty is often experienced when working with metal, in drilling holes that are round and not three-cornered. Grooves in the walls are also hard to overcome.

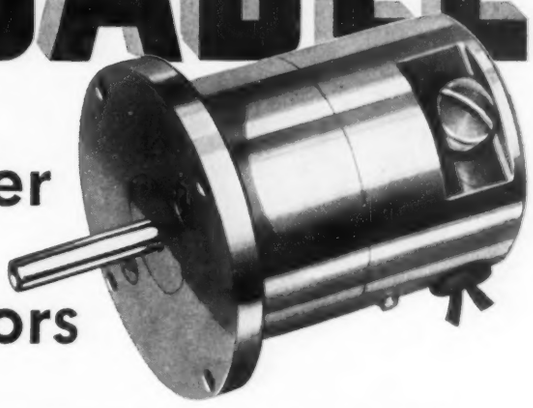
Good, true holes can be drilled best by chucking the object to be drilled in the lathe chuck or clamping it to a

(Continued on Page 540)





DEPENDABLE



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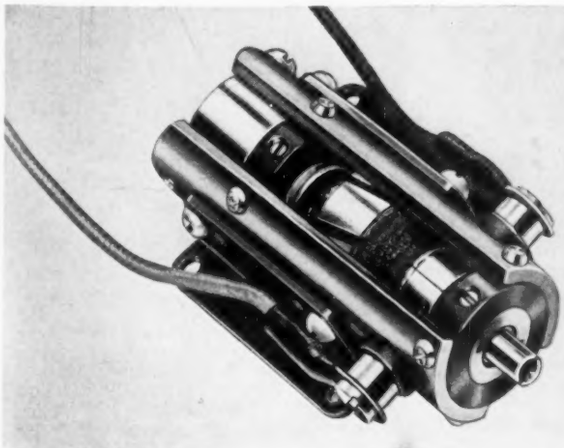
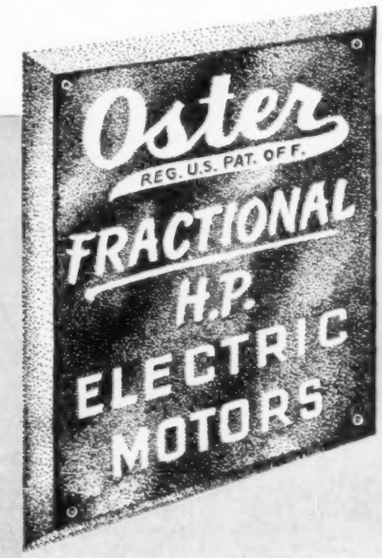
M-5





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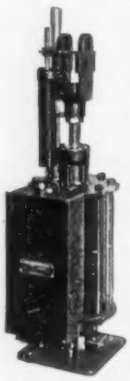
Boiler Meters for recording combustion conditions and guiding boiler operators. Described in Bulletin No. 44.

Multi-Pointer Gages for indicating factors such as draft, pressure, temperature and speed. These Gages are available with any number of pointers and any scale combination; in either the oil sealed bell or diaphragm construction.



Control Drive

Flow Meters for indicating, recording and integrating the flow of steam, water, sewage, air, gas and other fluids. Bulletins No. 39 and 300.

Recorders for pressure, temperature, drafts, liquid level and other factors.

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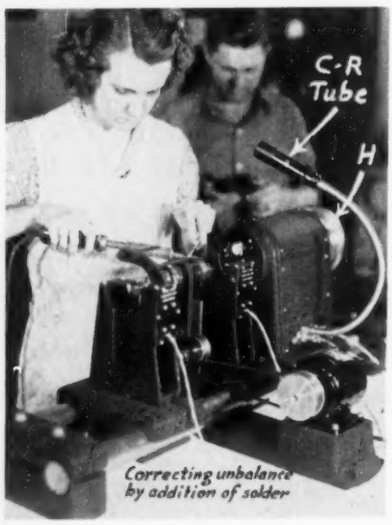
The Month's NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department as your source of information. Or write to Information Section, Instruments Publishing Company.

Balancing Machine for Mass Production Uses

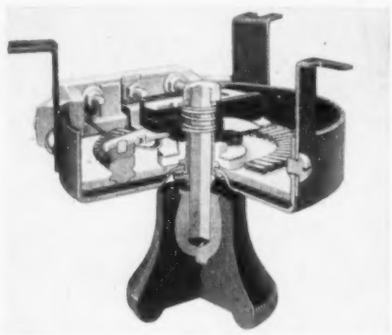
New "Dynograph" is a precision dynamic balancing machine for determining and indicating both amount and position of unbalance in rotating parts, through a single reading of the trace on the screen of a cathode-ray tube (an inertialess electrical indicating device which responds instantly to voltages applied to its control plates). Control voltages for the cathode-ray tube are generated as a result of the rotation and vibration of the unbalanced part while spinning in light-weight free-floating bearings. Amount of unbalance is shown directly by height of trace on scale of cathode-ray tube. Position of unbalance is also



shown by the trace, by indicating phase relation between the voltage produced by vibration and that produced by rotation. The control voltage due to rotation is produced by a special photoelectric generator which is "coupled" to the part being checked through the medium of a beam of light, no mechanical coupling being necessary. A constant correction position (opposite reference pointers) is obtained by turning the photoelectric generator with the handwheel (H) so that zero phase relation is always indicated. It is said that only a few seconds are required for the operator to read the unbalance in either of the two selected correction planes. A selector switch determines which end is being read. The scale may be calibrated in practical units of correction such as inches of solder or depth of drilled hole. Operator is given immediate indication as to whether he has made too much or too little change in correcting the unbalanced part. "Dynograph" is quite flexible and may be readily adapted to various balancing jobs within its capacity. It operates on 110-volt 60-cycle lighting circuit and is designed for bench mounting. With a 40" bed length, maximum distance between bearings is 15" and maximum swing 14", "Dynograph" is furnished complete with motor drive, tubes, belts, instructions and technical data, etc., ready for operation. Vibration isolation spring suspension mount is available where considerable extraneous vibration may be encountered.—*R. B. Annis Co. 1101 N. Delaware St., Indianapolis, Ind.*

Four-inch Rheostats

New "Bulletin 69" Pressed Steel Rheostats are said to meet the need for a small, sturdy, power rheostat having a large number of steps and ample current carrying



capacity—a combination of features hitherto obtainable only in the more costly rheostats. These new rheostats are 4" in diameter with as many as 43 stens of control and are rated for 100 watts. Spacings through air and creepage distances between parts of opposite polarity and between current carrying and grounded parts meet the requirements of A.I.E.E., NEMA and Underwriters' Laboratories for 300-volt service. In addition to these characteristics, "Bulletin 69" Rheostats feature balanced contact arm, "dead" shaft construction and copper graphite contact shoes. They are available in front or back-of-board mounting, in single and multiple assemblies.—*Ward Leonard Electric Co., Mount Vernon, N. Y.*

Dust-tight Relay for Aircraft Applications

New dust-tight relay, especially designed for aircraft applications requiring high current-carrying capacity without sacrifice of compactness and light weight, is a solenoid-operated device with the normally-open contacts rated at 10 amperes d.c. These contacts will make or break 30 amperes at altitudes up to 40,000 feet. The coil contacts, and plunger are enclosed in a dust-tight housing, and the unit is corrosion-proof, meeting 200-hour salt-spray tests as stipulated by various government agencies. Relay can be furnished in a single-pole, single-circuit form with one normally-open and one normally-closed contact. Operating

THESE STEEL REEDS are the Heart of all "FRAHM" Instruments

In appearance, these reeds may resemble a paper of matches . . . but there the similarity ends. They are the heart of all Frahm Instruments for measuring speed, frequency and rate of vibration and are the *only* moving parts.

Each reed of the Frahm Instrument, like a pitch pipe, is accurately tuned to a definite period of vibration, and a number of reeds with an appropriate interval between each are grouped in a housing to form a matched set. When minute vibratory impulses enter the reeds through the frame on which they are mounted, individual reeds come into resonance and clearly indicate the frequency of the vibration. Being essentially simple and rugged in construction, and since there are no rotating parts to wear, instrument accuracy is indefinitely maintained.

This resonant-reed principle is incorporated in all Frahm Tachometers and Frequency Meters. Instruments are made in both hand and permanent mounting types for speeds or rates of vibration in various ranges between 900 and 30,000 per minute, or frequencies from 15 to 500 cycles per second.

We will gladly send you full details on any or all of these "Frahm" resonant-reed instruments and their applications. The following bulletins are available on request:

Frahm Tachometers, Bulletin 15901
Frahm Frequency Meters, Bulletin 16951

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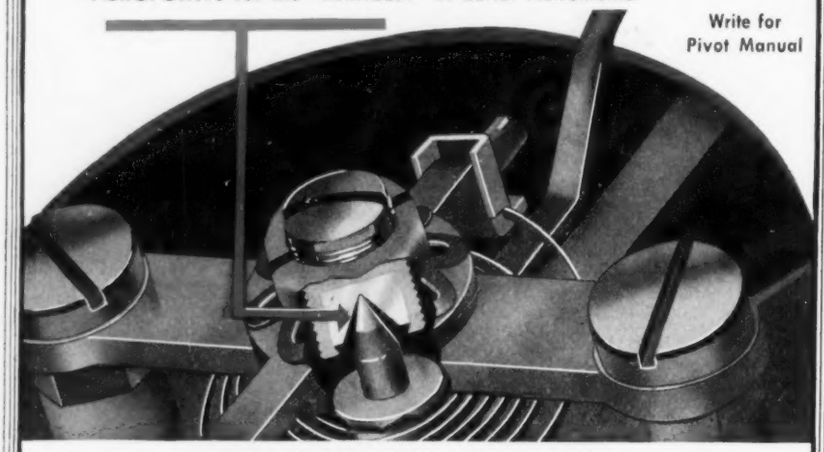

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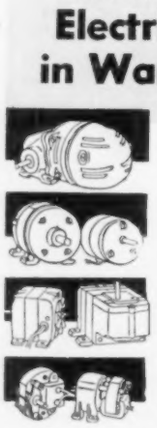

Dependable motors for A.C., D.C., or Universal operation, from 1/3000 to ½ horsepower, with speeds of from 3000 RPM to 25,000 RPM, and with almost any geared speed desired with worm or spur gearing. Light in weight and compact. More than 26 standard and innumerable special types.

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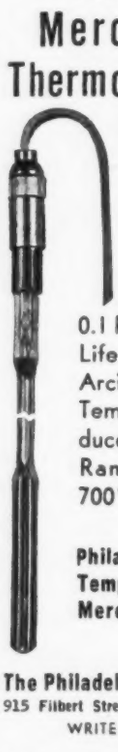
Philadelphia Merc-to-Merc Thermo-Regulators Feature



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coil can be furnished for either 12- or 24-volt d-c. operation. Relay can be mounted in any position on a metal or non-metallic base. When relay is in energized or de-energized state, contacts will remain in open or closed position without chattering, even when subjected to mechanical frequencies of 5 to 55 cycles per second at 1/32" amplitude (1/16" total travel) applied in any direction. Relay is designed for use in an ambient temperature range from 95°C. to minus 40°C. and will withstand 95% humidity at 75°C. on 48-hour tests and operate immediately thereafter.—*General Electric Co., Schenectady, N. Y.*

Water Detector Lock

New "Type P15NH Electronic Water Detector Lock" (Fig. 1) indicates water seepage in gasoline storage tanks, commands pump and alarm; is supplied with "Type H31 Probe Fitting" (Fig. 2) which is mounted in a standard pipe fitting on top surface of the tank, probe rod projecting down through tank to the level at which water seepage is to be detected—usually three inches from bottom of tank.

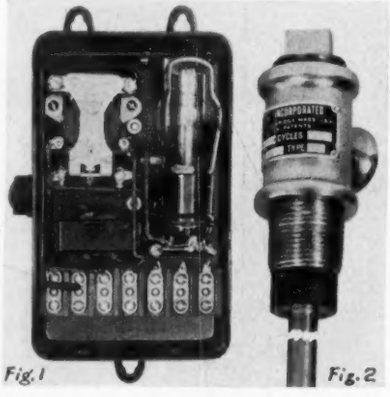
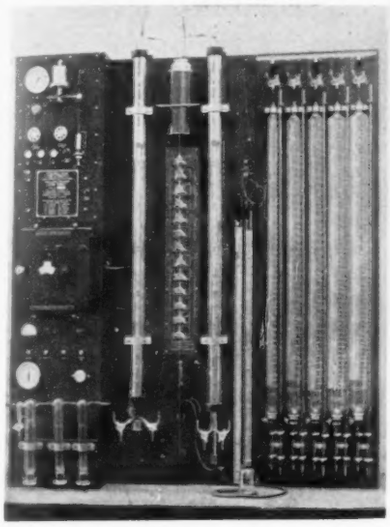


Fig. 1 *Fig. 2*

"Electronic Water Detector Lock" is located at any point remote from the tank and wired to the probe. While the probe rod is entirely immersed in gasoline and as long as water seepage has not reached the probe, no signal is given. When water seepage rises to contact the probe tip, an electrical circuit is completed through the water itself, and the water detector lock operates, turning off pumping equipment and actuating an alarm circuit. Standard "P15NH" operates on 115- or 230-volts a.c.; battery-operated "P15NB" is also available as standard. Water detector locks will handle output loads up to 10 amperes at 115 volts a.c. "Type P15NH" is supplied in a weather-proof pressed-steel housing. Explosion-proof housings are also available. Probe fitting "Type H31" is furnished in brass, stainless steel and other metals.—*Photoswitch Incorporated, 21 Chestnut St., Cambridge, Mass.*

Low-temperature Fractionating Equipment

New "Semi-Robot" which has been added to maker's line of low-temperature fractionating equipment differs from the "Hyd-Robot" completely automatic recording low-temperature fractional analysis apparatus in that it is partly automatic. This new apparatus will have the same accuracy and efficiency as the "Hyd-Robot" equipment. Incorporated in the assembly are the high-efficiency "Super-Cool" columns, which are packed with 75 plus plate low hold-up "Heli-grid" packings. Incorporated in the "Semi-Robot" panel is an arrangement for automatic control of reflux cooling and distillation pressure, plus manually set precise micro-distillate rate valve. The "Super-Cool" column used in this equipment is said to be based on entirely new principles. It makes possible the attainment of true adiabatic column temperature gradients despite



residual heat leakage through vacuum jacket and the tendency to thermal lag due to heat capacity of the column parts. This column assembly makes possible the close fractionation of even very close boiling gaseous mixtures, in reduced distillation time, with usually less than one liter and as low as ½ liter liquid air consumption per distillation. Applications in present wartime emergency: controlling alkylation, catalytic cracking, butadiene toluene extraction, and other War Effort processes, through continuous checking of percentages and ratios of the difficultly-separable isobutane, isobutene, butene-1, butene-2, butadiene and n-butane components.—*Podbielniak Centrifugal Super-Contactor Co., 8312 S. Chicago Ave., Chicago, Ill.*

Power Packages for Aircraft Subassemblies

A new driving mechanism—"power package"—has been announced for use in aircraft subassemblies. Designs depend upon applications, are available for bomb-door operation, landing-gear and wing-flap operation, operation of control and protective devices, etc. Power package combines in one compact unit a motor, brake, clutch, and limit switch as well as indicators gears, and whatever else is required to do a specific job. Designed for 24-hour service, units can be obtained in ratings from about 1/100 hp. to 3 hp. Each element in the power package is reduced to its simplest terms to save weight and space. For instance, where either a brake or a clutch could be used, the brake is chosen because it has one moving part while the clutch has two. A new planetary gear system permits the use of a magnetic brake for some applications. Brake is of quick-acting friction type, stops

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AFTER THE STORM!

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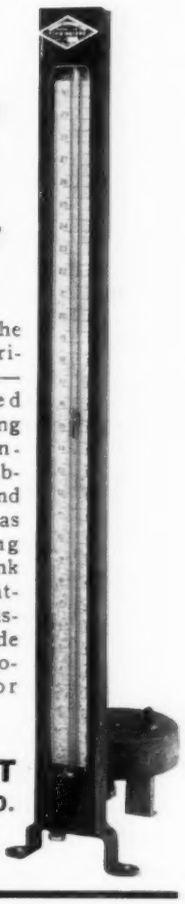

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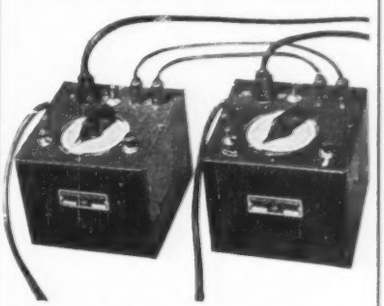
- Immediate automatic resetting
- Push button and remote control



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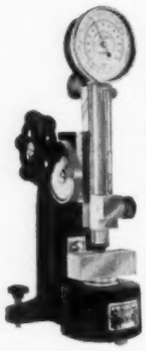

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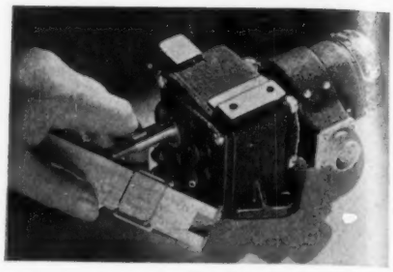
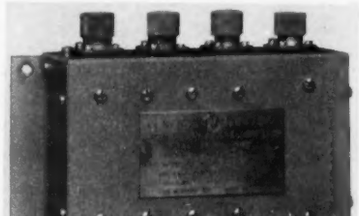
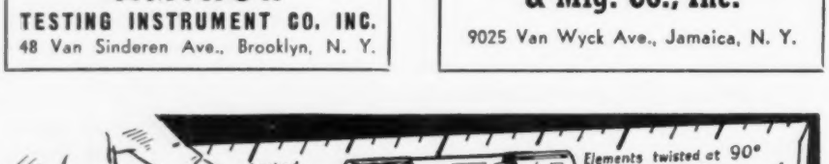


motor quickly to prevent overtravel and consequent jamming of driven plane assembly. When power is off, driven equipment is locked in place by the brake, to eliminate creeping of such subassemblies as landing gear. — *General Electric Co., Schenectady, N. Y.*

Enclosed Ballast for Aircraft Panel Fluorescent Lighting

A new enclosed fluorescent-lamp ballast, especially designed for use in aircraft, is announced. This new ballast operates four 4-watt Mazda F lamps, designated as T-6 × 2½, FA-5 (pinless) blue F-6 lamp, for instrument-panel lighting. It operates from a 26-volt, 400-cycle power supply at all frequencies from 385 to 416 cycles. An input-voltage variation of 23.5 volts to 28.5 volts is permissible. The new ballast is light (2.10 lbs.) and small (approx. 3½″ × 6½″ × 2″). Operation is unaffected by a wide range of ambient temperatures up to 140°F.—*General Electric Co., Schenectady, N. Y.*





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Glass-insulated Flexible Heating Element

Available in any length, by the inch, foot or yard, a new low-power flexible heating element known as the "Glasohm" is for use particularly in limited space and also as a flexible power resistor. The resistance wire is wound on a fiber-glass core and is protected by a fiber-glass braided covering almost as flexible as silk. "Glasohm" heating elements can be provided with any type terminals. Ratings are from 1 to 4 watts per body inch depending on the application. Operating temperatures up

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Split Core Current Transformers

Special Instrument Applications

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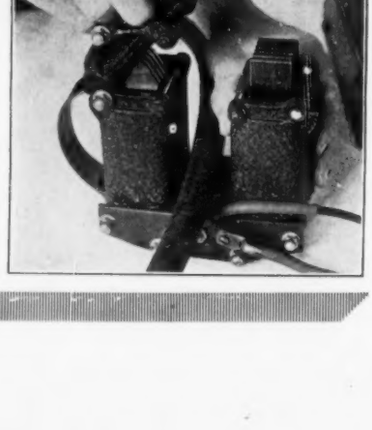
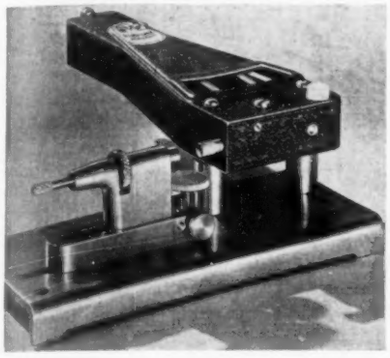


to 1050°F. Among applications: temperature-controlled ovens for oscillating radio crystals, heating aviation and marine instruments, localized heat for chemical apparatus and laboratory equipment, etc.—*Chromostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y.*

Visual Comparator for Rapid Production Inspection

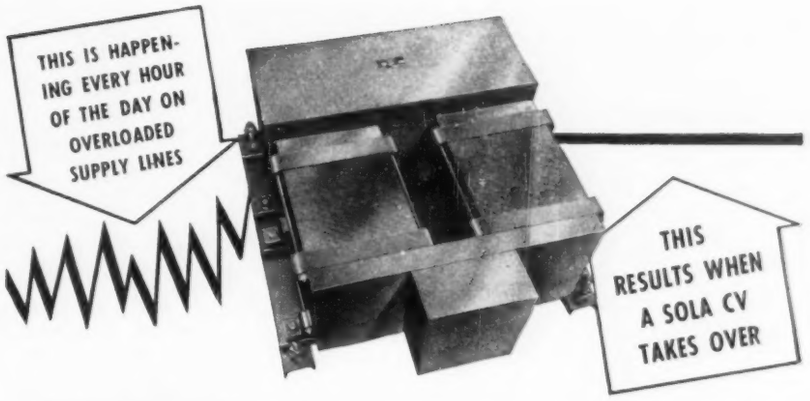
New "Micro-Chek" visual indicator comparator gage is an outgrowth of the effort of a Western New York manufacturer to convert its machinery and equipment to exclusive production of war material: it was originally designed to meet manufacturer's own large number of additional inspection requirements on precision parts. Instrument



has been developed to use a simple multiplying-lever mechanism and to put this multiplying device under the control of a push button. Used as a comparator type of gage, it is set by the use of two master parts, one having the limit of dimensional tolerance on the high side and the other having dimensional tolerance on the low side. Two limiting fingers on the instrument are set in this manner to arrive at the "go" and "not go" limits. Production parts thus may be compared to the master parts and then checked for "go" and "not go" limits simultaneously. Re-setting of tolerance indicators can be accomplished in a few seconds. Pointer stays in retracted position until button (white button in photo) is pressed. Gaging point pressure is adjustable from 2 oz. to 2 lbs. After putting this device into use in over 100 different inspection points, manufacturer decided to distribute it to others engaged in kindred work, believing that adoption would speed up the work of expert inspectors and also make it possible to train inspectors rapidly in industries where advancing war program requires enlarged personnel. It is said that "use has demonstrated that there is less fatigue among operators engaged in such delicate work." Two models are available: "Model A" multiplies movement 200 times; "B" 60 times. Prompt shipments to users who are able to furnish priority for their tool needs. — *Trico Products Corporation, Buffalo, N. Y.*

Tensile Testers

New table and floor model portable units of maker's tensile testing machines are announced. Expansion of scope and utility is exemplified by new table model illustrated. This is an "in-between-size" instrument—so that while small in size, it will physically check specimens up to a foot in length, also accommodating up to 9" width. It broadly covers tests of small objects and also goes up into the range of larger machines, for it handles up to 10,000 lbs. Versatility of instrument is said to be largely due to use of Dillon Dynamometer stress indicator, which permits wide limits of measurement with a uniformly small stress-reader. Height starts at 32" (table model) to 78" (floor type). Paper, plastics, metal, rubber, wood, etc., may be tested up



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Sola Constant Voltage Transformers automatically provide perfectly regulated voltage that remains constant regardless of supply line fluctuations. They have no moving parts, are self-protected against short circuit, and require no supervision. They're on the job 24 hours per day.

Standard designs are available in capacities ranging from 15VA to 10 KVA or special units can be built to your specifications.

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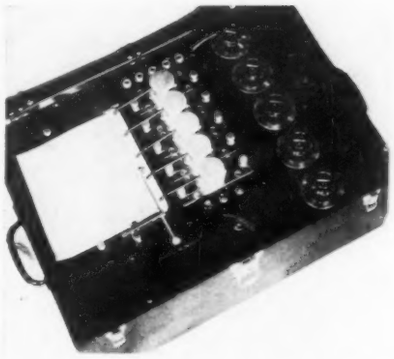

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DIRECT WRITING OSCILLOGRAPH
Quintuplet Model
(Inkless writing on electrically sensitive paper)

Designed for study of vibration in aeroplanes, analysis of pressure in rotating and reciprocating machinery, seismography, oscillographic analysis of welding and other electrical equipment operating on commercial power line frequencies. This direct-writing oscillograph will operate in any position and in the presence of excessive vibration. Particularly adapted to automatic remote control operation. No fragile crystals, permanent magnets nor moving coils.

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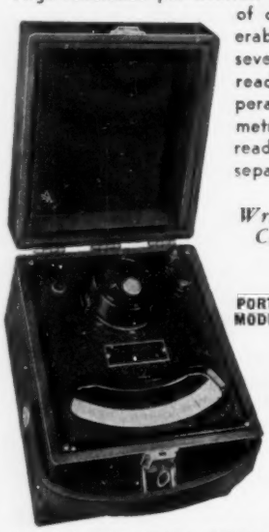
Engelhard Direct Deflection Indicators have all these features . . . Accurate sensitivity to the most minute voltage variations due to suspension type construction . . . High resistance per millivolt and no appreciable error when used with thermocouples of different resistances and on connecting leads of considerable length . . . Sturdy construction, adapted to use under severe conditions without danger . . . So simple that instant readings may be made directly in either millivolts or temperatures by someone unfamiliar with the principles of pyrometry . . . On kilns or furnace installations, where "spot readings" are desirable—the Engelhard Rotary Switch permits separate readings from many points.



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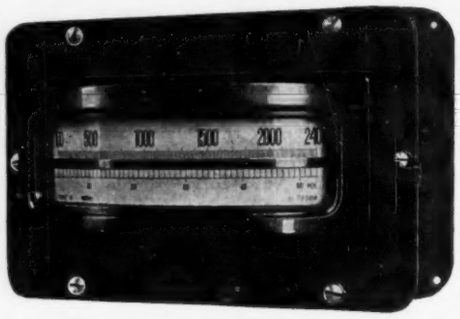
PORTABLE MODEL P-1



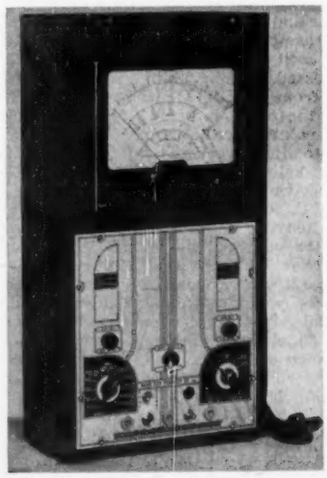
WALL TYPE W-1

CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST. NEWARK, NEW JERSEY

to 15,000 lbs., a number of capacities being now available in this range. Construction features include free floating bearing-supported dynamometer pins; 100% overload protection; universal loading; adjustment for temperature variation.—*W. C. Dillon & Co., 5410 W. Harrison St., Chicago, Ill.*

Multi-tester

Maximum sensitivity, flexibility and utility are said to be combined in new "No. 662" vacuum-tube multitester: actually an electronic voltmeter, ohmmeter and capacitymeter in one, with "an extremely wide and useful range of applications in laboratory and production-line tests, service work, etc." It is a vacuum-tube voltmeter on a.c., not a rectifier type. It furnishes capacity readings directly in microfarads, with a measurement ratio of 40,000,000 to 1. Designers forestalled all danger of shock on low-capacity measurements. There are no



test deals to short and no resetting is necessary when changing ranges. Indicating instrument cannot be damaged by checking a live resistor or by using a low range on high readings. Error due to line voltage fluctuation is eliminated by a VR105-30 regulator tube and associated circuits. Two models: one with a sloping panel and 4½" indicator, also an upright-style companion model (No. 622-V-7) with an 8½" rectangular indicator affording long scales for easy reading. Both testers have similar performance characteristics. Both are complete with leads and readily-accessible batteries, tubes and pilot light.—*Radio City Products Co., Inc., 127 West 62th St., New York City.*

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Accurate Within 1%
Between
1 & 200 Milliseconds

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Dynamometers, wattmeters, milliammeters and voltmeters. Also ultrasensitive meters both for A.C. & D.C., fluxmeters, electrostatic voltmeters from full scale 120 volts to over 20,000 volts, thermocouples, earth current meters, cable testers, etc.

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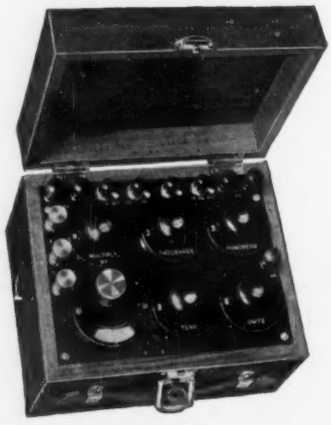
PORTABLE

WHEATSTONE BRIDGE



A high grade instrument for measuring resistances from a fraction of an ohm to 10 megohms. Contains a 4-dial rheostat, ratio dial, galvanometer and battery, all enclosed in a substantial walnut case. Nine coils per dial. Accuracy .1%. Built to endure.

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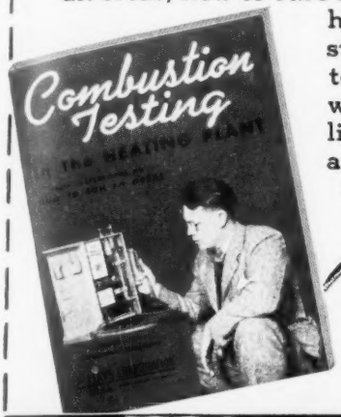

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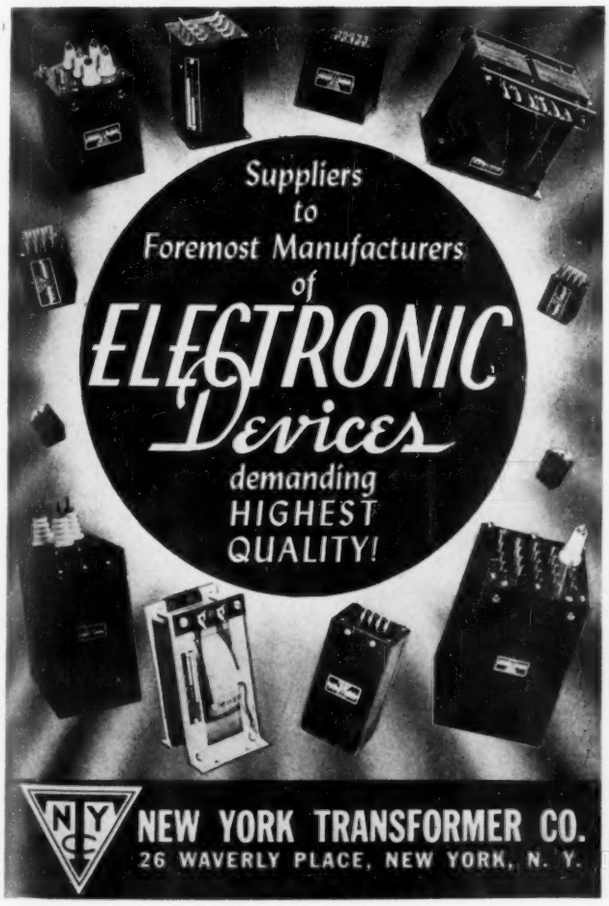

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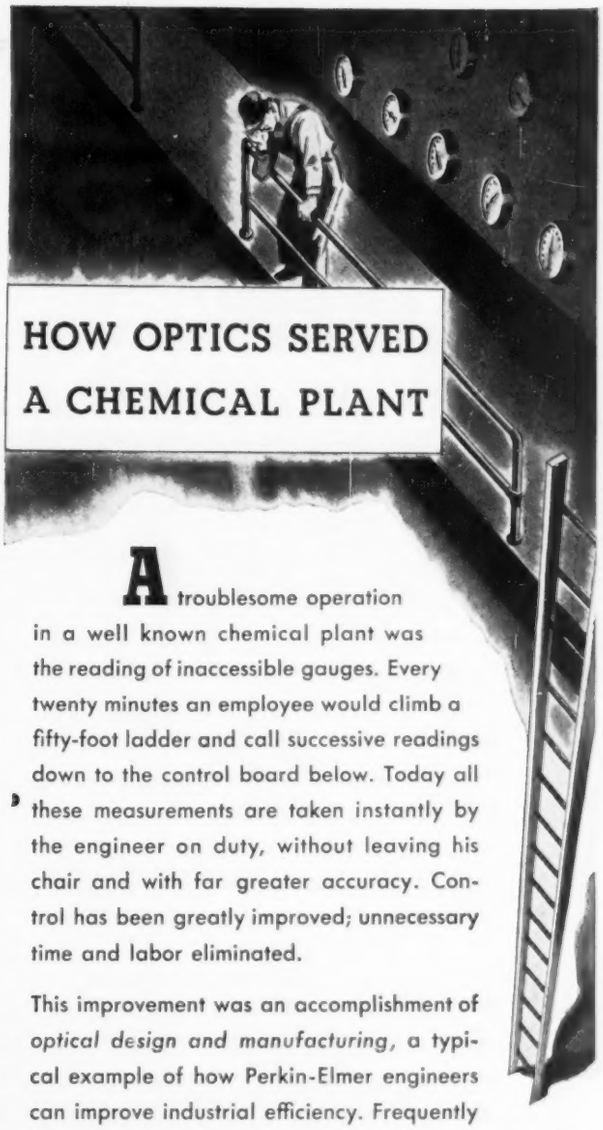

HOW OPTICS SERVED A CHEMICAL PLANT

A troublesome operation in a well known chemical plant was the reading of inaccessible gauges. Every twenty minutes an employee would climb a fifty-foot ladder and call successive readings down to the control board below. Today all these measurements are taken instantly by the engineer on duty, without leaving his chair and with far greater accuracy. Control has been greatly improved; unnecessary time and labor eliminated.

This improvement was an accomplishment of *optical design and manufacturing*, a typical example of how Perkin-Elmer engineers can improve industrial efficiency. Frequently the amazing science of optics can "team up" with chemical, mechanical or electronic methods to provide the answer to otherwise insoluble problems.

Despite the fact that The Perkin-Elmer Corporation facilities are and will be devoted entirely to the war effort for the duration, we shall welcome your letter describing present problems or future plans. If we can be of service now or in the future, we shall be glad of the opportunity.

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MANUFACTURERS OF PRECISION LENSES • PRISMS and MIRRORS

OPTICAL DESIGN AND CONSULTATION

Timers

Designed and made for those who appreciate and demand dependability and accuracy in such instruments.

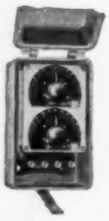
Among our extensive line are the following two popular models.

MULTI-CONTACT TIMER

Automatically controls a sequence of "on" and "off" operations of a single or a multiple number of electrical circuits in accordance with a predetermined operating program.

Used to control a series of machine operations in definite order — to automatically reverse or alternate in operation a group of motors, machines, or devices, etc.

DUAL CYCLE TIMER



with both "on" and "off" operation individually adjustable Repeat Timer especially adapted to industrial applications which require maximum flexibility. Has two reset timer mechanism mounted on a common base plate each with its individual micrometer setting knob and dial.

Just what are Your Needs?

by

Cramer

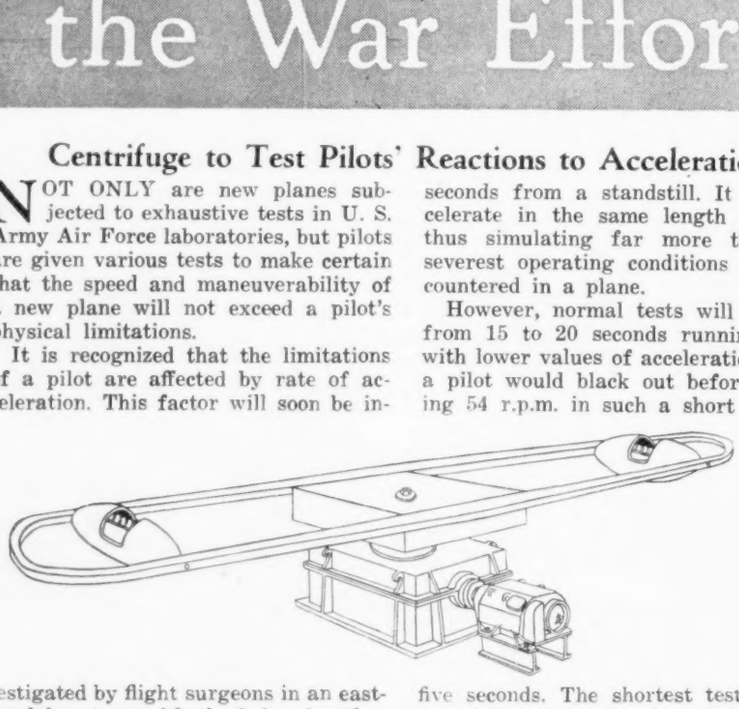
The R.W. CRAMER COMPANY Inc.
CENTERBROOK CONNECTICUT

Instruments in the War Effort

Centrifuge to Test Pilots' Reactions to Acceleration

NOT ONLY are new planes subjected to exhaustive tests in U. S. Army Air Force laboratories, but pilots are given various tests to make certain that the speed and maneuverability of a new plane will not exceed a pilot's physical limitations.

It is recognized that the limitations of a pilot are affected by rate of acceleration. This factor will soon be investigated by flight surgeons in an eastern laboratory with the help of a "human centrifuge" which will reproduce acceleration conditions corresponding to all known or desired air manoeuvres.



The centrifuge, for which the General Electric Company is now building an electric drive, consists of a horizontal boom with a driving shaft at its center. Cockpits are mounted near each end of the boom, 20 feet from the center shaft. [Quite a difference from the dimensions of the familiar centrifuge for test-tubes!]

The boom will turn as rapidly as 54 revolutions a minute, at which speed the radial acceleration at the cockpit radius is 20*G*. The centrifuge will be able to reach this speed in only five seconds from a standstill. It will decelerate in the same length of time, thus simulating far more than the severest operating conditions now encountered in a plane.

However, normal tests will average from 15 to 20 seconds running time, with lower values of acceleration, since a pilot would black out before reaching 54 r.p.m. in such a short time as five seconds. The shortest test run is expected to be approximately five seconds and the longest to be three minutes.

To simulate the effects of any desired air manoeuvres, a flight surgeon will mark a pattern of speed changes on a chart in a heavy line. This line is scanned by a G-E control device which then commands the driving motor to follow the prescribed speed-change schedule. Flight surgeons will observe the tests from a glassed-in control room, where master switches, speed selecting and recording devices, and testing instruments will be located. A separate room will house the control panel and an adjustable-voltage motor-generator set.

100,000,000-volt X-rays and Electrons

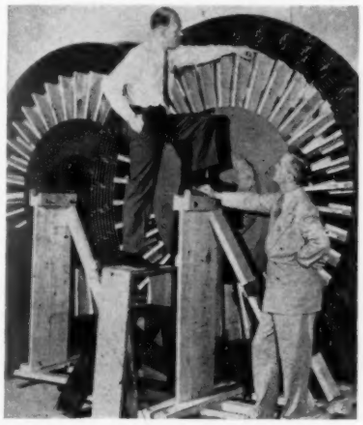
HOUSED in a special building with three-foot concrete walls, an induction electron accelerator which will speed electrons to energies of 100,000,000 volts, and which will produce x-rays of the same power, is being constructed as an addition to the General Electric Research Laboratory. It was inspected in August by the National Inventors' Council, of which Dr. William D. Coolidge, G-E Vice President and Director of Research, is a member. This giant instrument will give electrons energies far higher than have ever been given by a human agency before. One of the investigations with the equipment will be a determination of the maximum thicknesses to which x-rays can usefully be applied for examination of armor plate and other very thick cross sections. Eight inches of steel represents the practical limit for convenient use of the present million-volt industrial x-ray unit.

Dr. Ernest E. Charlton, head of the x-ray section of the G-E Laboratory, and W. F. Westendorp, have been responsible for the design and construction of the new accelerator. Its main part will be an electromagnet weighing 125 tons. Between the 78″ diameter pole faces where the magnetic field will be most intense, will be a six-foot hollow glass "doughnut," inside which the electrons will be speeded in vacuo. The cross section of the doughnut will be elliptical, 5″ high and 8″ across, with ¼″ wall thickness. It will be assembled

of 12 molded sectors, which are being made by the Corning Glass Works.

The doughnut is a merry-go-round for electrons. Starting from the filament of an electron gun (like that of a cathode-ray tube) they will be whirled around a quarter of a million times in 1/240th of a second, on each trip receiving a 400-volt push. Their total travel will be about 800 miles, which means that their path has to be guided with extreme accuracy. As Dr. Charlton stated, it is "like shooting on a curve for a distance as great as from Schenectady to Chicago and hitting a three-inch target."

The operation of the electron accelerator is similar to that of a transformer: the "primary" consists of two 98" coils of insulated copper conductor 0.88" in diameter. Each coil has forty turns and contains a ton of metal. The



Dr. E. E. Charlton, right, and W. F. Westendorp, with the large coils to be used in the induction electron accelerator.

"secondary" consists of the flow of electrons in the evacuated space of the accelerator doughnut.

The electrons are speeded up during the first quarter of each cycle of the 60-cycle a.c. At the end of this quarter-cycle the high-energy electrons will strike a target and generate a beam of highly penetrating x-rays, which will emerge from the machine, together with scattered high-speed electrons. Even *these* electrons will be able to penetrate two inches of steel. The control room is outside the thick wall, and a periscope using four mirrors will permit the operator to watch with safety. Above the control room is the largest single bank of capacitors in the country, with a capacity of 24,000 kva.

The induction electron accelerator bears a superficial resemblance to the cyclotron, but it is quite different. The cyclotron speeds positive particles by whirling them around in the field of a powerful d-c. magnet. The particles are accelerated only when they cross the gap between the D-shaped semicircular boxes, inside which they coast in a curved path on the rest of their journey. In the accelerator the electrons are speeded continually, and reach almost the speed of light.

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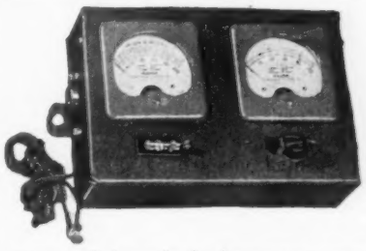

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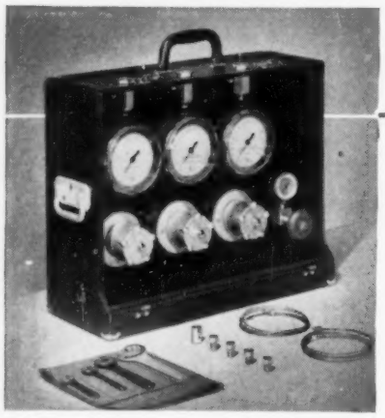

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AVIATION INSTRUMENTS DEP'T (Cont'd)

Training Military and Civilian Personnel

(Concluded from Page 522)

text material and the division into three specialists' courses was a simple matter. It did take some work to arrange the courses of study, but that also was accomplished and at present the school is functioning smoothly with both programs in operation.

In the military courses, the student is trained as a specialist in only one phase of aircraft instrument work. His training may be on (1) pressure instruments, (2) electrical instruments or (3) gyroscopic instruments. He is trained to do complete overhaul on all types of instruments that fall within the classification, so that he will be able to "Keep 'Em Flying" even if there are no replacements available.

In this way, American School of Aircraft Instruments is doing its part in the War Effort and is looking forward to the time when peace will come and we will be able to again turn our efforts to the training of aircraft instrument mechanics for development of commercial aviation which is sure to follow.

Shop Kinks

(Concluded from Page 528)

face plate and then placing the drill in a chuck in the tail stock. The secret of good holes lies in the drill, however.

If a hole slightly smaller than the diameter desired is drilled first, and then a drill of the correct diameter is

ground especially, an accurate, smooth-walled hole will result.

To prepare the correct diameter drill, merely chamfer both corners of the cutting edges where they join the sides of the drill. This radius prevents grooves being gouged by the sharp corners of the drill.

Overhaul Procedure—Pendulum Assembly

(Concluded from Page 523)

5. If the vane settings are incorrect, bend the vanes to make the correct setting. Extreme care must be used so as not to break the solder joint between the vane and shaft.

6. If the end play is too great, rest the pendulum assembly on one end of the shaft, place a hollow punch over the other end of the shaft and tap lightly with a hammer until the end play has been reduced to the desired amount. After doing this, check carefully for broken solder joints. If the end clearance is excessively large, it will be necessary to melt the solder by use of a soldering iron and move the vane down on the shaft.

7. Hold the pendulum assembly up, so that one of the four flat sides is horizontal; and check the clearance between the vane and body against a light. The clearance should not be greater than the thickness of the spacer washer between the vane and the body. The vanes must swing perfectly free and must not clear the pendulum body at the holes more than is necessary to give perfect freedom. Bend the vane as much as necessary to line it up with the body and have perfect freedom. Repeat this operation with the other three vanes. Extreme care must always be used in bending.

8. Check each pair of vanes for freedom by holding the pendulum assembly in its normal position with the bottom resting on the bench. Swing the vanes back and forth several times and allow them to come to rest. Repeat this several times. They should stop in the same position each time. Finally, move each pendulum vane off to first one side and

then the other and allow it to return to its normal position. It should return to the same position each time; and it should make at least four half-swings before coming to rest.

9. If the shaft holes in the pendulum body are so elongated that the vanes rub on the body, it will be necessary to overhaul the pendulum assembly.

10. To disassemble the pendulum assembly, first cut the shafts on the inside of the pendulum assembly with a pair of diagonals. Be careful to remove all burrs with a file before removing the shafts, so that no damage will be done to the holes when the pieces are removed.

11. Lap the four sides of the pendulum body until smooth and clean. Polish each flat side with a fine Arkansas stone until a mirror finish has been obtained.

12. In the overhaul of the pendulum assembly, three sizes of shafts are used: 0.063″, 0.065″, and 0.068″. The material is stainless steel, centerless ground round shaft. The length of the shaft used in the pendulum assembly is $1\frac{7}{16}$″. Choose the diameter shafting that just fits the holes in the body. Polish the shaft to a mirror finish and burnish the body holes with the polished shaft. Square off the ends of the shaft for approximately $\frac{1}{16}$″ from each end.

13. Remove the old pieces of shafting from the pendulum vanes. Lap the back and face of the vanes until smooth and clean. Polish until a mirror finish is obtained. Remove all solder from the countersunk holes in the front side of the vanes with a No. 27 drill. Using the same drill, countersink the back of the vanes approximately 0.005″ (five thousandths). This is to remove any burrs that might cause trouble.

14. Broach out the vanes from the front side with a broach so that the final diameter is approximately 0.0002″ to 0.0003″ (two to three "tenths") less than the size of the shafting to be used. These holes should be small enough so that the shafting will have to be tapped into the hole from the back side of the vane. This prevents the solder from running down the shaft and sealing the spacer washer to the vanes; and also keeps the vane securely in place prior to soldering.

15. Polish four spacer washers on a fine Arkansas stone.

16. Place one of the upper shaft vanes face down on a bench block and place a shaft in the vane hole and tap it until the shaft extends about $\frac{1}{16}$″ through the vane. Be certain that the shaft is perpendicular to the vane. Place this shaft into the high shaft hole on the pendulum body, holding the shaft on the inside of the pendulum body. Adjust the vane on the shaft so that it is parallel to the pendulum body. Remove the vane and shaft and place a spacer washer on the shaft. Again place the shaft into the body hole, holding the vane in position; check the clearance between the body and the vane at the free end of the vane. This clearance must not be greater than the thickness of the spacer washer. Solder this vane on the shaft. Then place a spacer washer over the other end of the shaft and with hollow brass punch, tap second vane on shaft and solder. Adjust vanes for end play. (This end play should be barely perceptible.)

17. Repeat above operation in other set of vanes. Clean thoroughly, being sure to remove all soldering flux. Wash thoroughly and clean in jeweler's rejuvenator. Wash assembly in clear warm water until all traces of rejuvenator have been removed and dry under clean low-pressure air.

18. Check all clearances, adjustments and freeness of assembly.

19. Check rubber pendulum buffer on the pendulum assembly used in the Gyro-Horizon. If the buffer is worn, loose, cracked, sticky or hard, replace with new buffer.

20. Check body roller and stud assembly on pendulum assemblies used in Bank and Climb units. This roller must be perfectly free without appreciable side play. and absolutely free from rust, flat spots or grooves. If any of these

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The manometer is fully described in Bulletin 22. Copy will be mailed on request.

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Figure 1

1. ENLARGED ASSORTMENT of thermocouples all instantly interchangeable *without change in instrument calibration.*
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4. Unusually heavy and rugged movement essential in a portable pyrometer.
5. Greater accuracy. Construction of thermocouple assembly eliminates junction errors.

Figure 2

Figure 3

Figure 2 shows the unique method of attaching rigid or flexible connecting arm. Figure 3 illustrates easy attaching of thermocouples to arm yoke.

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conditions exist and cannot be removed by ordinary means of polishing, replace the body roller stud assembly. Lubricate the roller with one very small drop of Sperry Instrument Oil. Check the roller in the bail ring groove. Roller should have approximately 0.001″ play.

21. In the event the shaft holes in the pendulum body are worn so badly that shafting larger than 0.068″ would be needed to overcome side play, it will be necessary to rebush the body holes as follows:

(a) Run a 3/32″ drill through the body holes.

(b) Make four bushings of bronze or brass 5/64″ long by 0.096″ outside diameter.

(c) Drill a 0.0625″ hole through the center of the bushing.

(d) Tap these bushings into the body holes. They should be a press fit.

(e) Broach out holes to equal the size of a 0.063″ shaft.

(f) Proceed on the overhaul of the pendulum body as previously mentioned.

22. The bushings for the pendulum vanes are the same but for length, which is 1/8″ long. The procedure for installation is the same as for body bushings.

(The Economy Rejuvenator used for this overhaul may be obtained from C. & E. Marshall Co., Jewelers' Suppliers, Chicago, Illinois.)

This Relative Thing Called "Precision"

(Concluded from Page 509)

for size and concentricity with the inside of the bushing; and also at the same time inspecting the squareness of the end of the bushing with its axis. All the above data can be quickly determined on the one gage.

In conclusion I would like to summarize the reasons why visual gages are supplanting old style conventional gages so rapidly. First—the elimination of the human element. Varying degrees of sensitivity on the part of the inspector are eliminated because errors are magnified so that they are visible to the inspector. No one as yet has found a way to magnify the sense of touch. Second—the speed of dial indicators. You instantly see the amount of error in the indicator. Moreover, you can not only see the condition of one dimension; but, due to the adaptability of dial indicators, these can be arranged so that several dimensions can be inspected simultaneously. Third—dimensions can be inspected with relation to one another, an operation which is practically impossible with solid or conventional type gages. Fourth—dial indicators though they may wear can be reset whereas conventional gages which wear become useless. Fifth—adaptability of dial indicators is one of the strongest assets. They can be applied in so many ways, in so many positions. They lend themselves readily to most gage problems.

The Pitfalls of Temperature Measurement

(Concluded from Page 499)

ployed, large errors may result from variations in the temperatures of the capillary and spring. The compensating means is never perfect, so errors creep in as these temperatures approach extremes. Thus we find it advisable to avoid placing the capillary or instrument where wide variations in temperature can be expected. The spring of this instrument is usually subject to large stresses, so we must be careful not to overheat the bulb. However, a small permanent strain of the spring can be readily corrected for because the scale in this case is nearly uniform. There is a more or less general impression that this mercury thermometer is subject to large errors accompanying changes in the height of the bulb relative to that of the rest of the system. There will be no appreciable error provided that the pressure in a stiff-walled bulb is kept well above the vapor pressure of the mercury. Since both the internal pressure and the vapor-pressure vary with temperature, a safe height at

one temperature of the bulb may not be safe at another temperature. If heights approaching 100 feet from bulb down to spring are contemplated, the maker of the instrument should be consulted.

Thermoelectric Thermometers

The pitfalls which we have not mentioned in the general discussion are found principally in loose electrical connections and dirty switches and slidewires, also in exposure of connections between wires of different thermoelectric properties to varying temperatures. To a lesser extent we are troubled occasionally by grounds and by leaks from power circuits to thermoelectric circuits. It is well known that the connections from a thermocouple to a millivoltmeter must be tight or else the instrument will read low. To be sure, a loose connection to a potentiometer is less serious, but errors nevertheless creep in. The sensitivity required for balancing is lowered. The errors caused by leaks and grounds are increased. The thermoelectric effects of decreased thermal conduction across connections are increased. An open circuit may make a potentiometer appear to be balanced.

A properly designed housing for the head of a thermocouple—where it is connected to extension leads—serves to keep both of these connections at the same temperature. This is not important where iron-constantan couples are connected to iron-constantan leads, but it is very important where chromel-alumel couples are connected to copper-constantan leads, and in some other cases. The head of a thermocouple may get rather hot, when a large e.m.f. will develop at the copper-chromel connection and another one at the constantan-alumel connection. These e.m.f.s will be of opposite sign, and will be nearly equal if the temperatures of the connections are nearly the same and not above 150°F. Above this temperature the two couples do not agree.

Let us look at the other end of the extension leads. These connections must also be enclosed. A little farther in the circuit and we come to a reference junction compensating resistor, perhaps. This will be found to be made of nickel wire. The change in the *IR* drop across this resistor is supposed to equal the change in the net e.m.f. of the reference junctions for any change of temperature. Of course we shall find these connections near the resistor, possibly in a well. But we cannot expect to be able to exactly match the change in *IR* drop in the resistor with the change in e.m.f. of the junctions for wide limits of temperature and for all kinds of couples. The agreements are pretty fair, however, and only small errors result at reasonable limits of temperature.

It is apparent then that the best results are obtained from keeping the instrument at a uniform temperature, at least not permitting rapid changes. Temperature gradients within the instrument may result not only in a difference in temperature between the nickel compensator and the reference junctions but may set up—in recorders, for example—undesirable stray e.m.f.s at slidewire contacts and moving switches.

Inhomogenous thermocouples can be the source of serious errors. For example it is next to impossible to determine whether or not there is sufficient immersion if the couple is inhomogeneous. The inhomogeneity may include a limited part of the couple. This is likely to happen when it has been installed in a muffle furnace with its hot end in the muffle and its middle part in the combustion space. Occasional inspections of installed thermocouples and protection tubes are always advisable. The replacement of a worn-out couple with a new one may result in peculiar situations. The user may have thought for years that the worn-out couple had been bought from a certain maker. Perhaps he thought it was a 13% rhodium alloy with platinum. So when he put a new couple of this type in its place the results were disastrous and possibly every other source of trouble imaginable was examined before it was learned that the old couple was a 10% alloy. The moral of this is—thermocouples are not easy to identify if they are not marked.

In the use of a potentiometer there are some very simple operations which are sometimes carelessly spoiled. For example, the galvanometer *should* be kept on its open circuit

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zero. If it is not and the operator is in a hurry, the potentiometer should be standardized for no deflection of the galvanometer by the reversing of the standard cell switch. A thoughtless person may standardize to the zero mark. The user of a recording potentiometer may be inclined to let too much dirt accumulate on the slidewire and presently he may be surprised to note that some of the records appear to be shifted immediately after a good cleaning.

The standard cell used in potentiometers is a two-legged affair designed to generate a constant e.m.f. without having its temperature automatically controlled at a fixed value. The temperature coefficients of the two legs are of opposite sign. So this cell must be placed where the two legs will always be at the same temperature. These temperatures must not exceed the limits from 32° to 140°F. If a cell is damaged by passing these limits or by accidental momentary short-circuit, it will generally recover in a few days to a few weeks. A good cell will last for many years but the e.m.f. generated slowly falls from the standard 1.019 volts. If a new potentiometer is compared with one which is five or six years old, a discrepancy of a few tenths of a percent may be expected. I have known fairly experienced persons to overlook this simple fact.

Resistance Thermometers

Our first precaution is above all things tight connections. The common industrial resistance thermometer has three leads. Two of these leads and their connections must have and remain at equal resistance. This means that they must be kept at the same temperature and not injured. If any permanent change comes about there is no means available of determining whether this change is in the leads or in the thermometer. Only in case four leads are available can the change of resistance be located. Hence we find that it is necessary to retest the industrial forms of resistance thermometers at various temperatures even though it may be made of pure platinum. Of course if it is made of nickel then there is never any sure way of extrapolating test data.

Most resistance thermometers will not withstand much overheating. If the thermometer wire is insulated with organic material a temperature of 150°C. is near the limit. Platinum thermometers with the wire mounted in refractory materials are being employed occasionally for measuring temperatures as high as 1000°C. For such purposes the wire is large in cross section and the resistance very low. In this connection we might remark that resistance thermometers are more sensitive to exposure at high temperatures than thermocouples and once spoiled cannot be restored.

Optical and Radiation Pyrometers

The successful employment of these pyrometers depends to a large extent on familiarity with the laws of radiation obtained either through study or long experience. For example, we find in the Temperature Symposium that Worthing lists eight properties which are designated as emissivities of different sorts. We learn of true temperature, color temperature, brightness, apparent, or blackbody temperature. Apparent temperature to a radiation pyrometer is far different from that obtained with an optical pyrometer sighted at the same object in the open. The optical pyrometer is least likely to mislead a novice especially because things look the same to it as to the eye, while the radiation pyrometer of the thermocouple type sees mostly infrared.

The most successful type of optical pyrometer has been the so-called disappearing filament. In this the observer matches the brightness of an incandescent filament of the pyrometer lamp with that of an optical image of the hot object focused in the plane of the filament. In setting the current through the lamp to the brightness match it is necessary to observe that the center of the visible part of the filament does indeed disappear. If dark fringes appear outlining the two edges of the filament then something is wrong. It may be that the source is too small or that some object is throwing a partial shadow in the line of sight. Possibly there is a large piece of dirt on the front lens. Now if we have a good match with this pyrometer we can't be sure of the temperature this corresponds to unless we know the radiation laws which are applicable. If the incandescent object is not inside a furnace then a great deal of information is required to reach a final conclusion as to what the temperature is. Since this instrument requires an observer to obtain a reading it is designed primarily as a portable instrument and in this form has shown its greatest utility. In fact in experienced hands it serves as a great aid in checking high temperatures even when in some cases these are being indicated by a permanently installed pyrometer.

The radiation pyrometer on the other hand is almost useless as a portable instrument. This is primarily because of the difficulties of judging departures from blackbody conditions and the effects of carbon dioxide and water vapor. Most of the radiation pyrometers used in industry are permanently installed and checked in place either with thermocouples or optical pyrometers. The receiver of heat in these pyrometers has been generally one or more tiny thermocouples. For this reason the temperatures of the walls surrounding the receiving thermocouples have a marked effect on the generated e.m.f. The best results are obtained within limited ranges of temperatures of the receiver, and water jackets are frequently used when the receiver is likely to become too hot. Extension leads are not used but to offset this slight advantage over thermocouples the temperature scale designed for the radiation pyrometer is very far from uniform, being highly compressed at its lower end. This makes it very difficult to apply some types of corrections which might otherwise be readily calculated. Up to the present time the accuracy of the radiation pyrometer has not approached that of the base metal couple up to around 2200°F. nor of the rare metal couple up to about 2800°F. Improvements in design and inventions in this field may better the performance of radiation pyrometers very much. We are in need not only of higher accuracy but of quicker response and of sensitivity to radiation at lower temperatures. At present the lower limit is around 1400°F.

Instruments in the War Effort

Dew-point Indicator Guards Heat Treatment of War Production Components

TO increase war production and safeguard quality of steels treated in controlled atmosphere furnaces, an automatic dew-point indicator developed by Westinghouse metallurgist P. R. Kalisher provides a continuous check on the purity of the hydrogen gas flowing over the metal. Such instrumental control is especially important where the dew

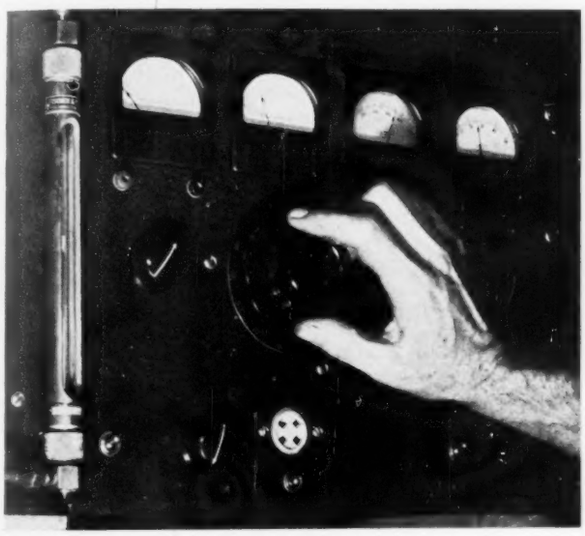


Fig. 1. This detector signals the presence of contaminating moisture or oxygen in the highly purified hydrogen gas commonly used in heat treatment of steel.

point of the treating gas must be maintained in the critical region of —40°C. to —70°C., or for precise furnace conditions such as required for bright annealing, and for chemi-

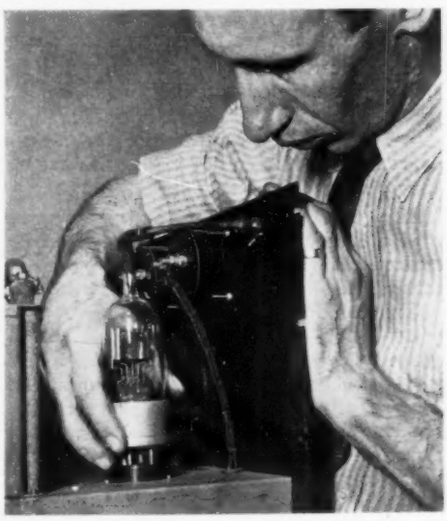
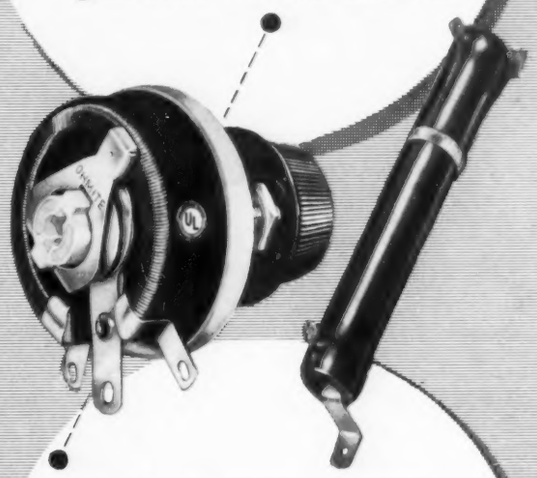


Fig. 2. P. R. Kalisher inserts in its socket a new electron tube he developed for detection of water vapor or oxygen. A continuous sample of the furnace gas (in by hose at top, out by hose at base) passes through this two-element tube.

OHMITE

Resistance Units

for Permanent Performance in Test Apparatus or Control Instruments



The basic design and construction features of Ohmite Rheostats and Resistors have been tested and proved through years of service in critical applications. The extensive range of types and sizes makes them more readily applicable to almost every requirement. And the experience of Ohmite Engineers is especially helpful in selecting the right units for each need. This is well worth remembering when producing instruments for *today*—and *tomorrow*. Many stock types. Units produced to Government specifications or engineered for you.

Send for Catalog and Engineering Manual No. 40

Write on company letterhead for complete 96-page book—gives helpful information and engineering data on the selection and application of Rheostats, Resistors, Chokes and Tap Switches.

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BE RIGHT WITH OHMITE
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Tap Switches

Capacitors

● A capacitor type to meet every electrical, electronic or radio requirement — that's the basic aim of the Aerovox organization. Two decades of intensive specialization, together with production facilities second to none, stand behind that aim today.

Therefore, when yours is a problem of capacitance, just send it to Aerovox for engineering collaboration, recommendations, quotations. Latest general catalog sent on request.

Heavy-duty bakelite-case mica capacitor for electronic and radio functions. Typical of the wide range of Aerovox capacitor types in regular production.

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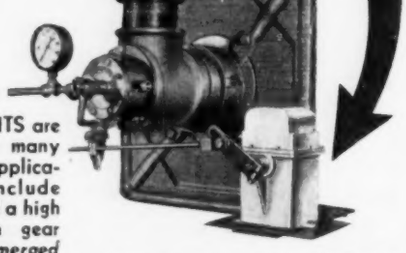
BARBER-COLMAN POWER UNIT

ON A HAUCK OIL BURNER



These POWER UNITS are ideally suited for many industrial control applications. Features include built-in switches and a high torque motor with gear reduction, *oil-submerged* for long life and dependable operation. Control action may be governed by a thermostat or other indicating or recording instrument. The picture shows a POWER UNIT as applied to the air-oil valve on a Hauck industrial type oil burner.

Many other uses of Barber-Colman Controls are suggested in the bulletin "CONTROLS for INDUSTRY" Write for your copy.

MAXIMUM SERVICE Controls by BARBER-COLMAN COMPANY MINIMUM MAINTENANCE

BARBER-COLMAN COMPANY

1202 ROCK ST. • ROCKFORD • ILLINOIS

cal processes, using purified dry hydrogen or similar controlled gases.

To give steel proper characteristics, it often is heated in an atmosphere of highly purified hydrogen that is practically free of moisture and oxygen. Ordinarily, to measure moisture in the gas where dew points are less than 0°C., a cooled and polished metal plate is inserted in the gas stream and the temperature noted when condensation of moisture first occurs. However, below —40°C. this method

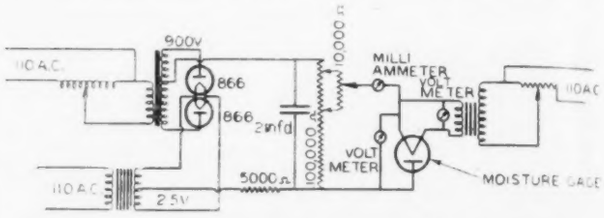


Fig. 3. Simplified schematic of connections. The milliammeter in the plate circuit indicates when moisture or oxygen flows through the detector tube. The unit can be made recording or automatic in control.

becomes largely guess-work, the uncertainty being around 8°C., and even skilled testers disagree on values of the same gas. The new instrumental method insures reliable and accurate determination of moisture and oxygen content in hydrogen (or disassociated ammonia) gas.

In operation, the gas flows through a 2-element tube containing a tungsten filament and plate. Electrons flying from the hot filament to the plate continually bombard the gas. If the gas is pure dry hydrogen all the electrons reach the plate. But any oxygen or water vapor in the gas immediately picks up some of the electrons and form negative ions, thereby reducing the electron current. This change of current in the plate circuit indicates the degree of impurity in the gas. The sensitivity of the instrument is sufficient to detect one-thousandth of humidity in outdoor air on an average summer day: the instrument detects 0.004% water vapor in furnace atmosphere.

Detector Speeds Tube Production

INCREASED production of high-power radio tubes being built at the Westinghouse Lamp Division for the armed forces, has been made possible by the development of a mechanical detector that automatically sorts filaments by spectroscopic analysis, Dr. Harvey C. Rentschler, director of the Division's research laboratories announced.

Known as a thorium detector, the device was invented by Dr. N. C. Beese, laboratory staff physicist. It is credited with cutting hours and guesswork from the necessary testing of wires before they are used in radio tubes.

Government requirements for radio transmitters, detector and receiving tubes necessitate in some cases the use of pure tungsten wire and, in others, thoriated tungsten wire. These filaments when heated produce the necessary electrons for power. If the tubes are made with the wrong kind of wire they burn out in a short period of time.

Introduction of a small percentage of thorium into a tungsten wire increases its ability to emit electrons and gives increased efficiency to certain types of tubes. The different tubes require the tungsten or thoriated tungsten filaments for maximum efficiency, but they are not interchangeable.

Until recently, thoriated tungsten filament wire could only be detected by chemical or mechanical analysis. In the former process, wire was dipped in several acid solutions and the residue examined for thorium content. The other method consisted of heating the wire and if it snapped very easily, it was considered to have thorium in it.

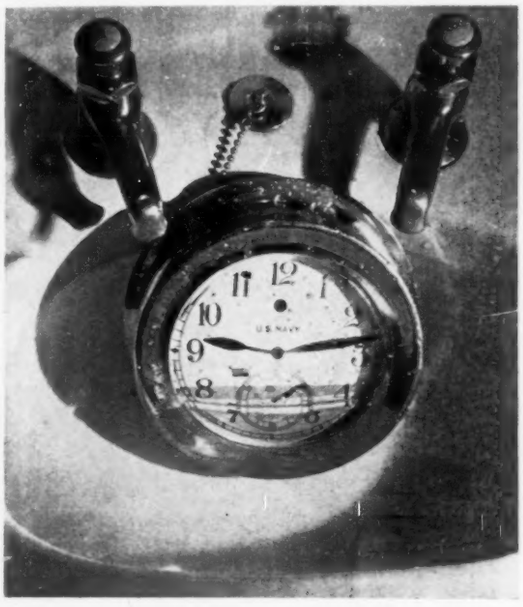
The thorium detector, in conjunction with a spectroscope, detects the presence of any appreciable amount of thorium in tungsten wire. The new thorium detection method, which eliminates guesswork and speeds up the testing of wire, consists of introducing a sample of pure tungsten or thoriated

tungsten wire into an electric carbon arc. As it burns completely, two lines appear in the spectrum if the wire is pure tungsten; four appear if it contains any thorium.

A portion of every coil of tungsten wire now passes the watchful "eye" of the instrument before being cut and made into small filaments. This sorting process separates the thoriated tungsten wire from pure tungsten wire.

Severe Test of a Water-tight Case

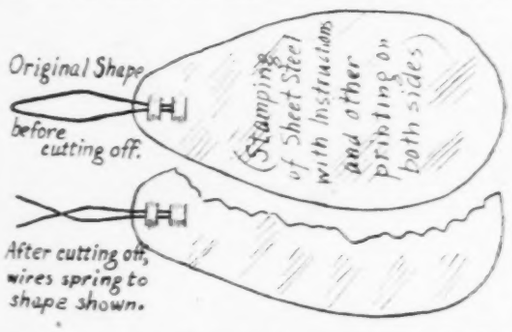
WATER-TIGHT after 112 days in Davy Jones' locker. That's the story of this clock case which was aboard the ill-fated Squalus when this U. S. submarine sank near the Isle of Shoals off Portsmouth, New Hampshire, in May



1939. When the Squalus was raised 112 days later, this clock "was the only mechanical device in working order," [according to a news release okayed by the Navy Department]. The Plexiglas crystal on the clock was made completely air- and water-tight by an ingenious heat fusing technique known as the "Perm-O-Seal Method," developed by Dutcher Bros. of New York.

SHOP KINK—PEN CLEANER

IN five- and ten-cent stores, needle threaders are sold which can easily be made into effective pen cleaners. Such is the kink described in a letter to *Instruments* by Herman W. Bocher, 4501 Richmond St., Philadelphia. Mr.

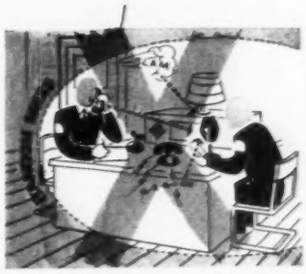

Original Shape
before cutting off.
After cutting off, wires spring to shape shown.
(Stamping of Sheet Steel with Instructions and other printing on both sides)

Bocher sent us a sample, which we have sketched (the illustration is actual size). Mr. Bocher advises that the ends of the spring-steel wire be cut off square. He does not mention what kind of pen he uses it on, but we believe that it will serve equally well on recorder pens of several kinds, on ruling pens, compass pens, etc.

The Shure Super-Cardioid Microphone

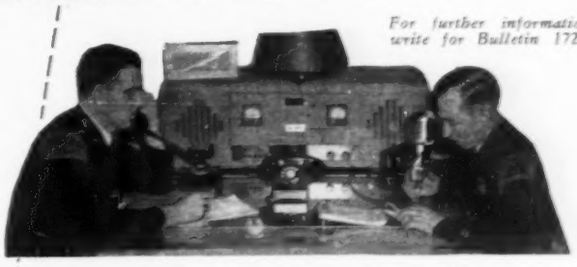
Reproduction of the voice that commands attention! The Shure Super-Cardioid Microphone combines special engineering for more efficient voice response, with the Cardioid pickup pattern . . . sensitive at the front—dead at the rear. This diagram of the photo below shows how the Super-Cardioid rejects background noise and other unwanted sounds. It "spotlights" the pickup of sound on the operator. Contrast this with .

The Conventional Microphone



This Microphone picks up sound from every direction as you can see in the diagram at the left. Background noise, reverberation, room reflection interfere with the important call. The Shure Super-Cardioid is the exact answer for Airport and Police Broadcast, and for Industrial sound applications.

For further information, write for Bulletin 172W



SHURE BROTHERS

Designers and Manufacturers of Microphones and Acoustic Devices

225 West Huron St.
Chicago, Illinois

Instrument Societies

Atlanta

The November meeting of the Georgia Society for Measurement and Control was held on the 23rd at the Atlantic Steel Co. Auditorium, State & 16th Streets Atlanta. The meeting was preceded by a dinner served in the dining room adjoining the Steel Co. Cafeteria. Twenty-six members and their guests were present. At Mr. Davis' suggestion, as the dinner ended, each rose, introduced himself and named the company he represented. Those present were asked to reconvene promptly in the auditorium.

Approximately forty members and guests attended the meeting, which was called to order by President M. V. Davis at 7:45. The objects and policies of the Society were stated and expanded on by Mr. Davis. The need for interchange of ideas between members and the benefits to be derived by industries and instrument manufacturers was pointed out.

Mr. Davis introduced Mr. C. F. Stone, President of Atlantic Steel Co., who made some timely remarks on the value of coöperation among plants such as represented by him. Mr. Stone introduced Mr. H. Carl Wolf, President of the Atlanta Chamber of Commerce and of the Atlanta Gas Light Co.

Mr. Wolf expressed his pleasure at being able to participate in the creation of a new organization that seemed destined to serve an important part in the promotion of the war effort of the Southeastern states. He called attention to the need for training and retaining in the South of men skilled in mechanical professions and predicted that through the activities of such organizations as these, the program would continue following the war.

Mr. Wolf introduced the principal speaker, Mr. Eugene W. O'Brien, Managing Editor of the W. R. C. Smith Publishing Co.

Mr. O'Brien prefaced his talk by saying that the organization could do much to further the war effort by increasing the production of war materials, the saving of man-hours and reduction of rejects through more complete control of processes.

Because of experience gained in service rendered the Government in Specification Board meetings involving changes and simplifications, Mr. O'Brien was able to report with optimism on the War of Production. A prediction of things to come covered the number of men to be in the armed forces during the coming year and the correspondingly larger number of civilians needed for maintaining these forces at highest efficiency. A plea was made for coöperation in the program for shifting of man power to essential war industries from some existing businesses engaged in peacetime production. Other ways in which those present could help were said to be by the maximum purchases of war bonds and stamps and by assisting small businesses to produce needed materials.

—D. D. BEACH

Chicago

At the November meeting of the Chicago Society for Measurement & Control (held as usual at the St. Clair Hotel) on the evening of Monday, November 2nd, Mr. R. E. Dufour, Assistant Chemical Engineer for Underwriters' Laboratories, Inc., presented a short paper explaining the basic purposes and functions of the organization with which he is associated.

The unusually large attendance of members and guests had anticipated an interesting tour through the laboratory. However, due to the work which that institution is performing in connection with our country's war effort, it was not possible for the society to make the tour. In lieu of this tour, however, Mr. Dufour presented a motion picture which was in its effect a tour through the laboratories and which was exceedingly interesting.

In the course of this motion picture the audience obtained some impression of the extensive use to which this organization utilizes commercial instruments. These uses would run the gamut of practically every type of instrument available on the market. We are sure that most of the audience had little conception prior to this picture of the extent of the activities of the laboratories and the thoroughness with which the tests are conducted.

—J. A. RIGGS

New Jersey

Your attention is called to the new meeting place, the Public Service Terminal Restaurant, 80 Park Place, Newark. It is just about opposite Kresge's department store on Broad Street. Will you please notify one of the officers if you like it or if you don't like it.

We had 42 for dinner and about 15 more came in afterwards at our November meeting. Ed Roth, of Tidewater, won the door prize, a kit of small instrument tools. Those Tidewater boys must know good tools, for Ed said: "They'll be snitched by eight in the morning."

Mr. Peters' talk on "Automatic Control of Industrial Processes" was very interesting. After discussing the differences between on-and-off, proportional, and proportional-plus-floating control, he illustrated the effects of different controller adjustments on a laboratory "process." Since it was a laboratory process, it was possible to duplicate conditions at any time. Among the unusual results was the production of a "hunting" control action by having the rate of reset too fast. He also showed the difference in the reaction of a controller, when a load change occurs and when the control point is shifted. His talk was punctuated by a number of questions from the floor.

The January meeting will be devoted to a Symposium on Thermocouples. Each speaker will be alloted ten minutes for his paper, to be followed by the usual question period. Here's a chance to get the right answer to your thermocouple problems. The lineup is:

"Tube-wall Metal Temperatures.."— Harry F. Moore.

"Thermocouple Lead Wire"—Nelson E. Chance.

"Molten Metal Temperatures" — Edward L. F. Engelhard.

"High Temperature Pyrometry"—A. C. Schmid.

"Low Temperature Measurements" — Joseph H. Cope.

—BOB GRAY

CHRISTMAS SEALS

Protect Your Home from Tuberculosis

This is Your Page, Society Members!

So see to it that your Secretary or Publicity Chairman uses a piece of it every month—as we have been urging them to do. Instrument societies can help in the War Effort as societies, in addition to the fact that most members belong to

The 10% Club

INSTRUMENT SOCIETIES CALENDAR*

CITY	DATE	PLACE	SPEAKER	SUBJECT	SOCIETY	SECRETARY
Atlanta	Dec. 28	Blue Flame Room, Atlanta Gas Light Co.		Open Discussion	Georgia Society for Measurement & Control	D. D. Beach, P. O Box 4569, Atlanta, Ga.
Baltimore					Baltimore Industrial Instrumentation Society	Fred Pullen, Bethlehem Steel Co., Sparrows Point, Md.
Chicago	Jan. 4	St. Clair Hotel	Flaw Detection: W. E. Thomas (Magnaflux), F.O. Fisher (Magnetic Analysis Corp.), G. A. Russ (C. S. Gordon Co.). Tech. Chairman W. W. Kagi.		Chicago Society for Measurement & Control	Carl Hope, 2626 W. 31st Blvd., Chicago, Ill.
Hartford	Jan. 19	Auditorium, Hartford Electric Light Co.	Clinton V. Johnson, Johnson Gage Co.	Screw Thread Gaging	Hartford Society for Measurement & Control	Stephen J. Zelle, Whitney Chain & Mfg. Co., Hartford, Conn.
Newark	Jan. 5	Pub. Service Term'l rest't, 80 Park Pl.	——————see above——————		Society for Measurement & Control (N.J.)	R. F. Robey, 409 Orange Ave., Cranford, N. J.
New York					New York Society for Measurement & Control	Marvin Fromm, 394 Second Ave., New York City
Philadelphia	Dec. 16	Engineers' Club	A. I. Dahl, Bureau of Standards, Wash'n	Stability of Thermocouples	Philadelphia Society for Instrumentation	W. D. Young, c/o Engineers' Club, Philadelphia
Pittsburgh					American Society for Measurement & Control	L. M. Susany, c/o Carnegie Institute, 4400 Forbes St., Pittsburgh

*Meetings begin at 8 P.M., Dinner served at 6:30 P.M. where meeting is held in a hotel or club.

Instruments

THE MAGAZINE OF

Measurement and Control

Vol. 15
JAN.
1942
No. 1

SPECIAL ISSUE :: IN TWO PARTS :: PART TWO

PART TWO

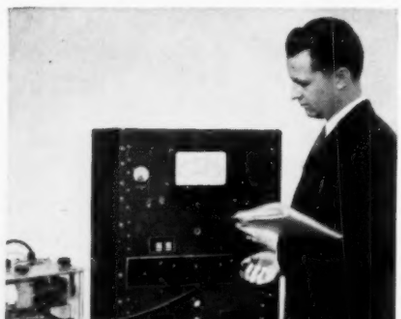
THE 1942 Instruments INDEX

These Testing and Measuring Instruments are accurate, versatile, easy to operate

NEW FREQUENCY STANDARDS ASSEMBLY

DEVELOPED BY BELL TELEPHONE LABORATORIES

MADE BY WESTERN ELECTRIC



This new instrument measures frequencies rapidly and with extreme precision. It has all the advantages of the larger, heavier, more costly assemblies, plus features found in no other instrument. Rightness of the design has been demonstrated through several years use by Western Electric in the manufacture of radio and allied equipment.

FREQUENCY STANDARD AND HARMONIC GENERATOR (lower panel): Generates stable and accurate signals, either harmonically rich or sinusoidal. With an oscillator assembly providing a 100 kc frequency, the output gives fundamental frequencies of 100, 50, 20 and 10 kc. Harmonic output may be used to the 1000th harmonic. Accuracy is better than *1 part per million* over long periods without the use of any temperature controls.

REFERENCE FREQUENCY AND HETERODYNE UNIT (center panel): Provides a crystal controlled oscillator circuit, plus modulator and amplifiers. Eight crystals can be plugged into the instrument, providing fundamental frequencies from 2 to 10 megacycles.

FREQUENCY INDICATOR UNIT (upper panel): Gives a direct reading of the frequency of the input signal from 0 to 100,000 c.p.s. Frequency is read on a large illuminated scale having five ranges.

Seven features you'll like:

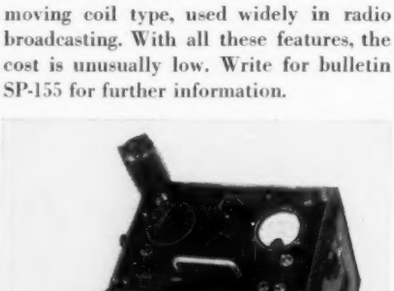
- High stability without temperature control
- High frequency operating range
- Either harmonic or sine wave output
- Multi-vibrator gives four fundamental output frequencies
- Built-in audio frequency modulator
- Small size—28" x 21" x 15"
- Portable—weighs only 150 pounds

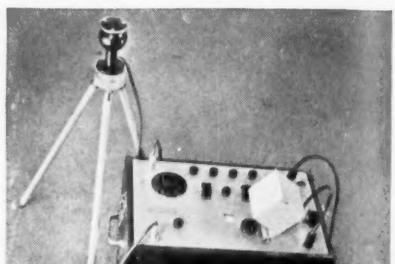
SOUND AND VIBRATION MEASURING INSTRUMENTS

RA-330 and RA-331 Sound Level Meters

If your work entails measurement of overall sound levels here is the instrument you need. RA-330 is powered from self-contained batteries—may be used anywhere. RA-331 operates on alternating current. Either model weighs but 22 pounds, measures 12" x 8" x 11" and meets all requirements of the American Standards Association.

These instruments have built-in calibration to keep them accurate at all times. Stabilized feedback is employed in the amplifier for greater accuracy. The meter is simple and fool-proof. With a little training, anyone can operate it. The microphone is a Western Electric 633A non-directional moving coil type, used widely in radio broadcasting. With all these features, the cost is unusually low. Write for bulletin SP-155 for further information.





RA-281 Recording Sound Frequency Analyzer

Here is the only instrument designed to give an accurate analysis and permanent record of sound and vibration frequencies. It divides any sound or vibration within its range into frequency components and simultaneously records the intensity of each frequency on a special paper chart.

In the analyzer, a drive motor sweeps the dial through the frequency range of 10 to 9500 c.p.s. as a narrow band quartz crystal filter selects only the frequency through which the dial is passing. The linear decibel chart is drawn in the recorder by an accurate stylus, clutch and drive system of special design.

A Western Electric 630A dynamic microphone (or a vibration pick-up), a synchronous sweep drive motor of appropriate speed and a carrying case for auxiliaries complete the equipment. Write for bulletin SP-156 for complete description and specifications.

Electrical Research Products Division
OF
Western Electric Company
INCORPORATED
76 VARICK STREET, NEW YORK, N. Y.

SPECIAL ISSUE OF *Instruments* THE MAGAZINE OF MEASUREMENT and CONTROL

Vol. 15, No. 1
January, 1942
Price $2.00
In Two Parts

PART TWO—THE 1942 INSTRUMENTS INDEX

More Than a Directory

CONTAINING the answers to 99% of the inquiries which *Instruments* receives from subscribers, this Supplement places at your instant command a wealth of information.

The Index Section—"Who makes what"—is the most important. Anyone who wants to know where he can buy or secure information on a certain product will find the product properly indexed and cross-indexed, and under it the names of the manufacturers of this equipment and manufacturers' sole representatives.

Indexing System. Products are indexed under the main word. In cases where a name is ambiguous, or where the item is known under two or more names, companies making such devices are listed under one heading and cross-references inserted under the other headings.

Specific Terms. You never are in need of "a gage" but of some particular kind of gage. Therefore we do not list manufacturers under broad general designations. For example, we do not list any names under the main heading "Meters" but we give the sources of supply for numerous classes and types of meters. Moreover, we do not list any names under "Meters, Liquid" alone, but we give under proper subheads the sources of supply for the *class* and *type* of liquid meter you may need.

Correctness of Headings. As explained above, main headings and subheads are technically correct. A few are not scientifically correct: they are names in common usage, recognized for the convenience of the majority.

Correctness of Listings. We have endeavored to list no firm names under specific headings unless the instruments made by such firms belong there by virtue of their design and construction.

For example, instruments called "colorimeters" but which cannot yield color specifications, belong under Color Comparators, Color Matchers, etc.

Also, an instrument called the "Integrating ————" or "Totalizing ————" may be nothing but a counting type, belonging under the subhead "Counting."

This we have done in relatively few cases, for it amounts to *censoring* the data sent to us. As a rule, we had to take the company's word that it could supply the product in question.

Completeness. More than 1200 manufacturers were canvassed in the last four months. Those that did not answer our first letter after one month received a second one. Again, a third letter was sent to nonresponders at the end of the second month. In the last few weeks we even sent representatives to call on manufacturers. Therefore, the omission of any manufacturer's name under any heading is due to the negligence of someone in his own organization.

CONTENTS

1. *Index to Instruments and Apparatus.* **In this section, products are listed alphabetically. Under each heading appear the names of the manufacturers of this equipment (and of the sole representatives of such manufacturers).** *Pages 6-76.*

2. *List of the Laboratory Supply Houses.* **Under the heading "Apparatus, Laboratory," on page 8, are listed companies specializing in laboratory supplies, equipment, instruments and apparatus.**

3. *Directory of Manufacturers and sole representatives,* **with complete addresses and brief descriptions.** *Pages 82-91.*

4. *Books of Interest to Instrument Men,* **will be a new annual feature.** *Pages 77-81.*

5. *Manufacturers' Literature.* **New literature pertaining to Instrumentation.** *Pages 95-98.*

6. *Index to Advertisers in this Section. Page 92.*

7. *Annual Index to Articles and Authors in Instruments, Volume 14, 1942. Pages 93-94.*

Every effort has been made to restrict the names in the Index Section to (1) the actual manufacturers and (2) the sole authorized sales agencies. On the other hand, whenever you desire to order at one time a variety of equipment, made by different firms, you may find it most convenient to get in touch with a recognized, competent, "laboratory supply house." These houses are listed under "*Apparatus, Laboratory,*" on page 8.

Instruments' Further Service. This Index contains the answers to *only* 99% of your inquiries. If you cannot find the product or the name you want, communicate with the Information Section, Instruments Publishing Co., 1117 Wolfendale St., Pittsburgh, and every effort will be made to furnish the information promptly.

Suggestions. We shall appreciate suggestions regarding:

1. Headings not at present found in this Index which should be there,
2. Firms listed erroneously, and
3. Other inaccuracies which may have crept in despite all precautions.

Published Monthly on the 15th by

The Instruments Publishing Company
1117 Wolfendale Street Pittsburgh, Pa.

R. RIMBACH Managing Editor
M. F. BEHAR Editor

Annual Subscription: U. S. $2.00. All other countries $3.00 *payable in advance* (remit by New York draft). Copyright 1942 by The Instruments Publishing Company. Entered as second-class matter January 26, 1932, at the post office at Pittsburgh, Pa., under the Act of March 3, 1879.

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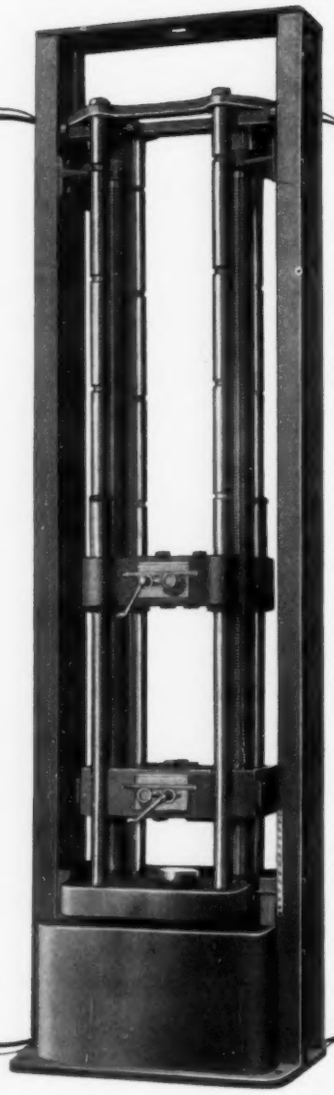
Boston: James Condon, 36 Myrtle St. (Lafayette 0829). *New York:* R. K. Farnham, 545 5th Ave. (Murray Hill 2-4217). *Chicago:* William Farnham, 201 N. Wells St. (Andover 4180). *Cincinnati:* Harold W. Haskett, Keith Bldg. (Parkway 7639).



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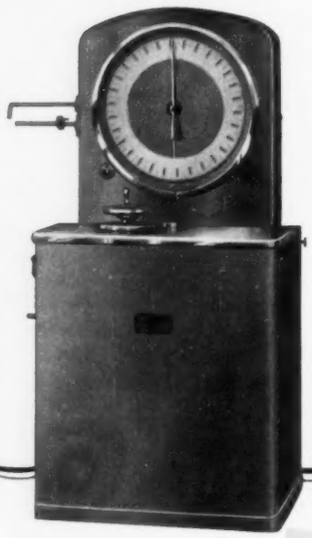

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ORIGINAL ACCURACY *maintained throughout service life of machine. No springs.*

5 SCALE RANGES *on pendulum indicator---at no extra cost.*

345 INCH (28 feet) INDICATING SCALE.

CONSTANT SPEED *regardless of load or temperature of oil.*

ONLY 1 HANDWHEEL. *Single turn changes from highest speed forward to highest speed reverse.*

These new Riehle Universal Hydraulic Testing Machines embody the most advanced hydraulic measuring and loading system. Ideal for both production or routine tests as well as the finest research work. Get the FACTS—send in the coupon below!

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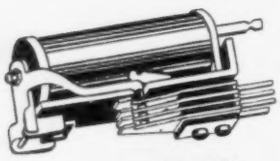

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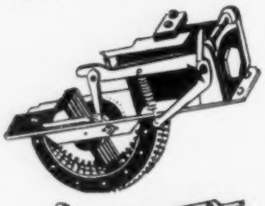

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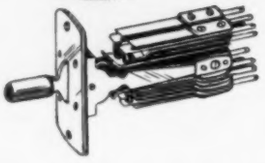

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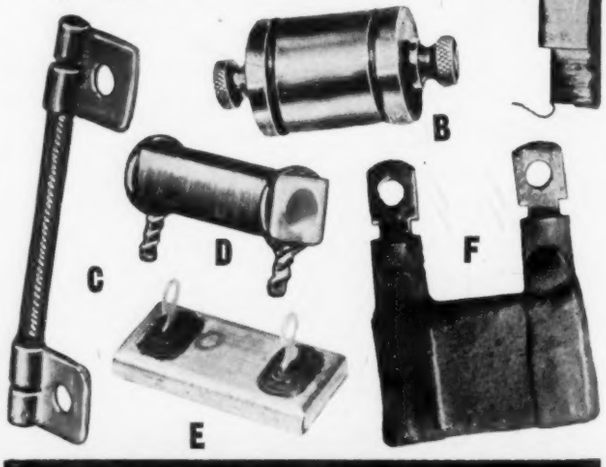

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ALARMS, Carbon Monoxide, Combustible Gas, etc.
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ALARMS, High, low water (See Alarms, Liquid Level)

ALARMS, Hydrogen Sulphide
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Reliance Instrument Co.
Roller-Smith Co.
Weston Electrical Inst.

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Wheelco Inst. Co.
Winslow Co.

AMMETERS, Microammeters
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Cambridge Inst. Co.
Clough-Brengle Co.
De Jur-Amsco Corp.
Engelhard, Chas.
General Elec. Co.
Hickok Elec. Inst. Co.
Pfaltz & Bauer, Inc.
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RCA Manufacturing Co.
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Roller-Smith Co.
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Supreme Instruments
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Triplett Electrical Inst.
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Wheelco Inst. Co.
Winslow Co.

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Esterline-Angus Co.
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Supreme Inst. Corp.
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Welch Mfg. Co.
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Wheelco Inst. Co.
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General Elec. Co.
HD Elec. Co.
Norton Electrical Inst.
Roller-Smith Co.
Rubicon Co.
Western Electro-Mech.
Weston Elec. Inst. Corp.

AMMETERS, Surge-Crest
General Elec. Co.

AMMETERS, Thermionic
Victor J. Andrew
General Radio Co.

AMMETERS, Thermo
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Cambridge Inst. Co.
General Elec. Co.
Hickok Elec. Inst. Co.
Rawson Elec. Inst. Co.
Roller-Smith Co.
Sensitive Research Inst.
Therm-Electric Meters
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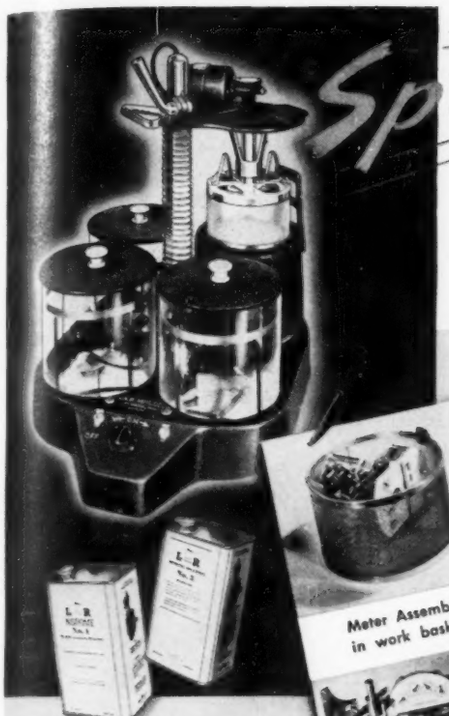

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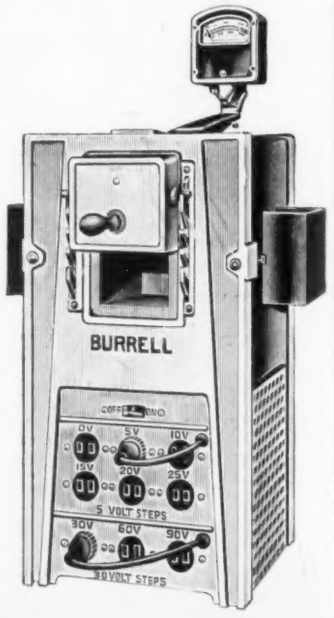

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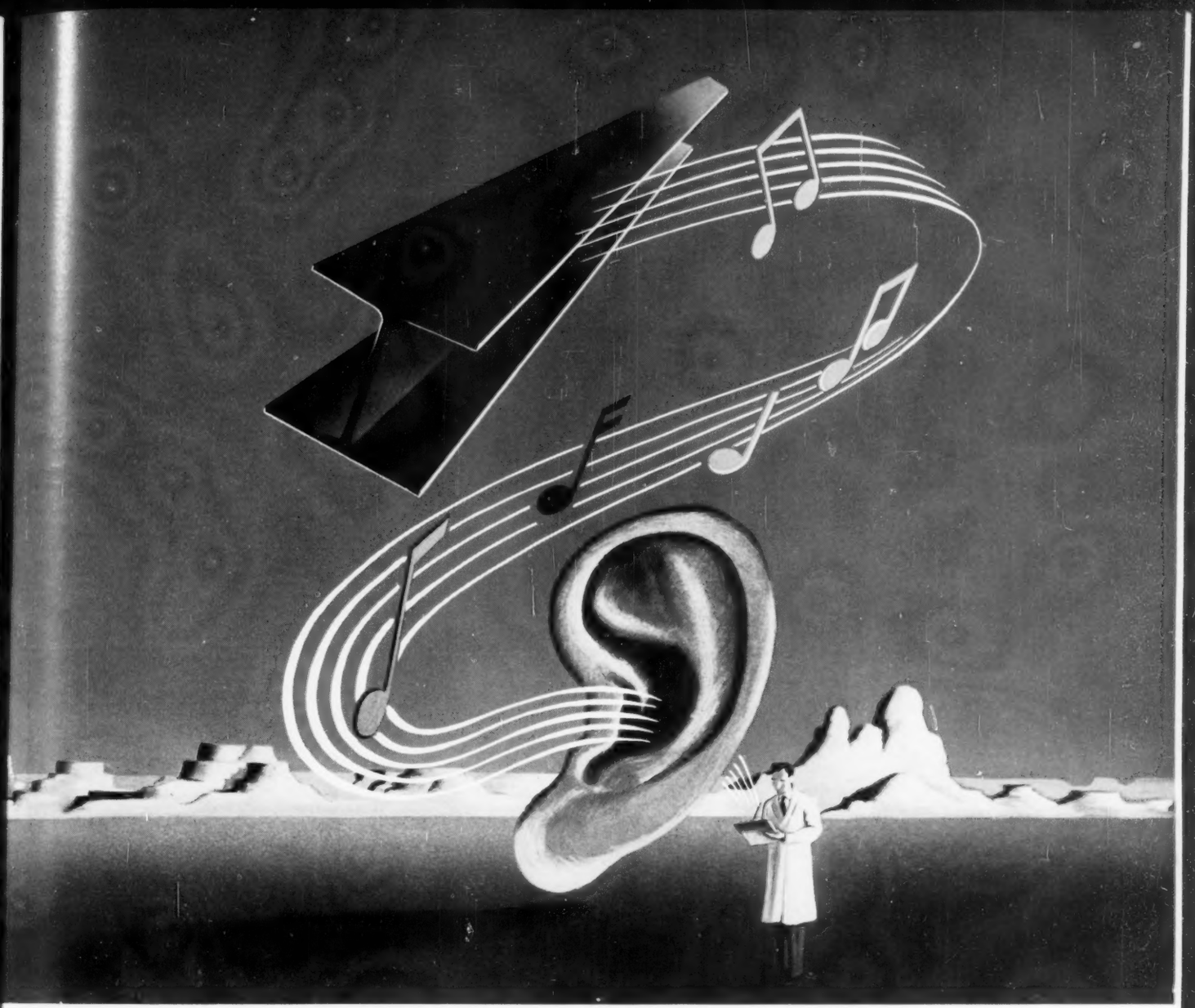

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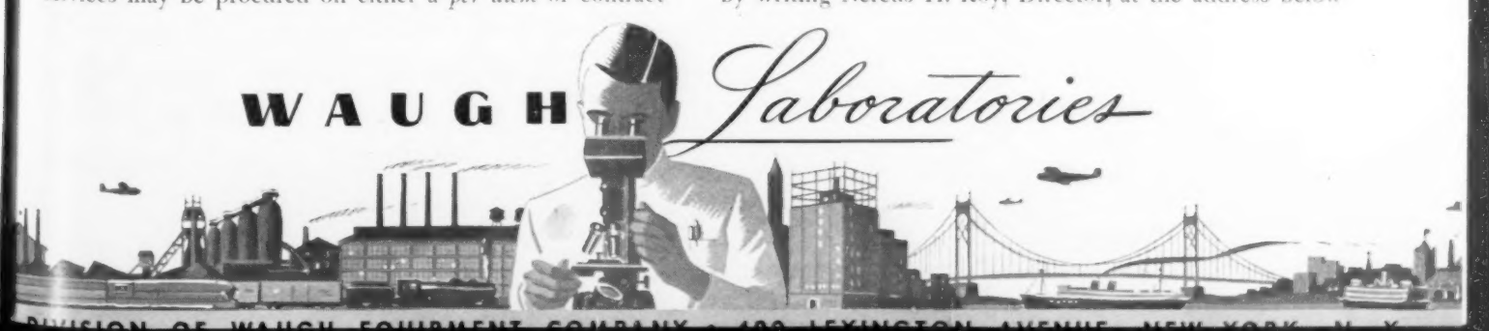

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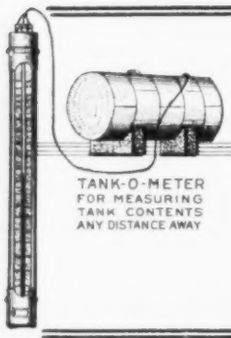

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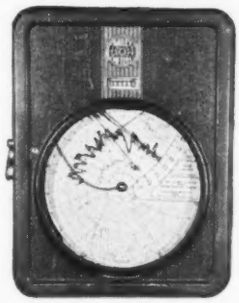

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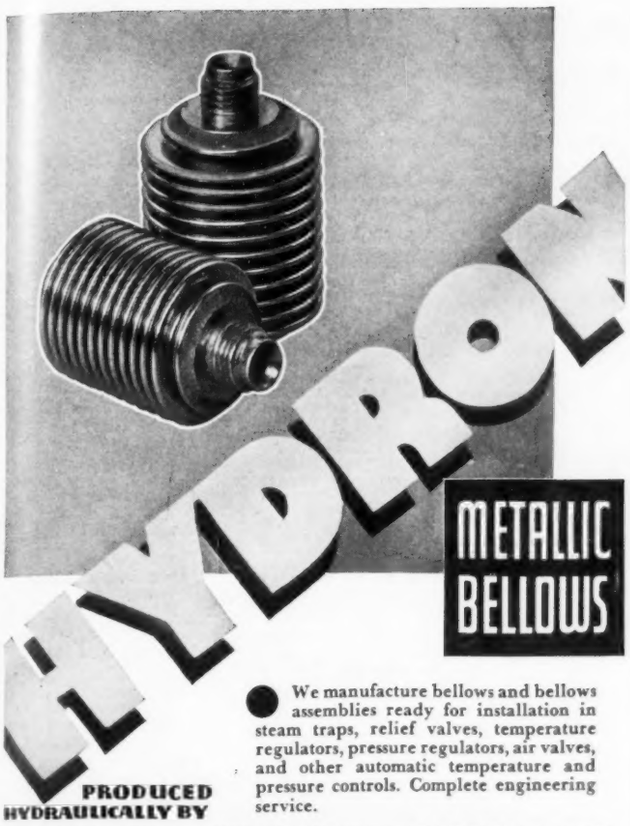

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Central Scientific Co.
Coleman Electric Co.
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Gray Instrument Co.
Industrial Instruments
Leeds & Northrup Co.
Sargent & Co.
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Central Scientific Co.
Gow-Mac Instrument Co.
Lantz-Phelps Corp.
Leeds & Northrup Co.

CELLS, Kerr
Batcher, Ralph R.
General Physical Lab.

CELLS, Photoelectric
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Burt Scientific Labs.
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Electronic Prod. Co.
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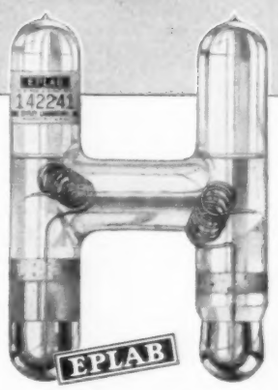

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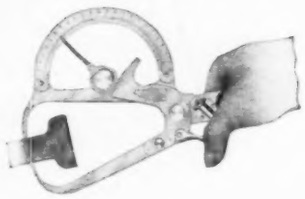

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Howard Clock Products
International Bus. Mach.
National Time & Signal
Paragon Electric Co.
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Warren Telechron Co.
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Howard Clock Products
International Bus. Mach.
National Time & Signal
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Stromberg Electric Co.
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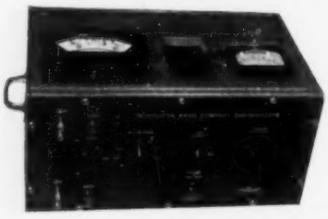

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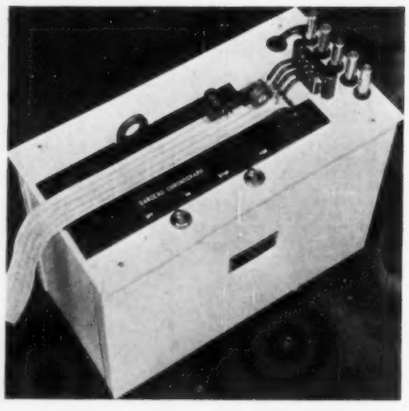

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For addresses, see pages 82-91

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COLOR MATCHING OUTFITS (See Color Comparators, Visual)

COLORIMETER TUBES (See Colorimeters, Visual)

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General Elec. Co.
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Klett Mfg. Co.
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Photovolt Corp.
Pho-Tron Inst. Co.
Rubicon Co.
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Electronic Research Labs.
Fisher Scientific Co.
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COMBUSTION, Indicators and Recorders (See Gas Analyzers, Boiler Meters, etc.)

COMBUSTION CONTROL EQUIPMENT (See Controllers, Automatic-Combustion)

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Andrew, Victor J.
Ballantine Labs.
Bernard, H. J.
Brush Development Co.
Clough-Brengle Co.
Daven Co.
Elec. Indicator Co.
Ferris Inst. Corp.
General Elec. Co.
Hickok Elec. Inst. Co.
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Leeds & Northrup Co.
Measurements Corp.
RCA Manufacturing Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

COMPARATORS, Mechanical
Farrel-Birmingham (Gear Tooth)
Federal Prod. Corp.
Ferner Co.
Gaertner Scientific
Hathaway Inst. Co.
Mico Instrument Co.
Park Sales
Pratt & Whitney
Scherr Co., Inc.
Standard Gage
Wilder, R. S.

COMPARATORS, Optical
Applied Research Labs.
Bausch & Lomb Optical
Cambridge Inst. Co.
Electronic Research Labs.
Ess Inst. Co.
Gaertner Scientific
Jones & Lamson Mach.
Leitz, Inc.
Scherr Co., Inc.
Spencer Lens Co.
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COMPASSES, Aircraft
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Elgin Natl. Watch Co.
Kollsman Inst. Co.
Moisture Register Co.
Pioneer Instrument Co.
RCA Manufacturing Co.
Star Compass Co.

COMPASSES, Automobile
Star Compass Co.
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For addresses, see pages 82-91

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Warren-Knight Co.

COMPASSES, Drafting Room (See Drawing Instruments)

COMPASSES, Gyro
Sperry Gyroscope Co.

COMPASSES, Magnetic
Ainsworth & Sons
Baker Compass Co.
Geophysical Inst. Co.
Gurley, W. & L. E.
Keuffel & Esser Co.
Kollsman Inst. Co.
Leupold, Volpel & Co.
Negus, T. S. & J. D.
Pioneer Instrument Co.
Star Compass Co.
Taylor Inst. Cos.
Testrite Instrument Co.
Warren-Knight Co.

COMPASSES, Marine
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Baker Compass Co.
Bendix Marine Products
Bliss & Co.
Geophysical Inst. Co.
Kuner Co., Max
Marine-Compass Co.
Negus, T. S. & J. D.
Star Compass Co.

COMPASSES, Radio
Hickok Elec. Inst. Co.
RCA Manufacturing Co.
Triumph Mfg. Co.

COMPASSES, Ship (See Compasses, Marine)

COMPASSES, Telltale (See Compasses, Marine)

COMPENSATION, Magnetic
Geophysical Inst. Co.

CONCENTRATION RECORDERS
Leeds & Northrup

CONDENSER, Electric (See Capacitors)

CONDENSER LEAKAGE, Indicators
Associated Research
Clough-Brengle Co.
Electronic Design Corp.
Hickok Elec. Inst. Co.
Industrial Inst. Inc.
Jackson Electrical Inst.
Leeds & Northrup Co.
Potter Co.
Radio City Products Co.
Rawson Elec. Inst. Co.
Tobe Deutschmann Corp.
Triumph Mfg. Co.
Weston Elec. Inst. Corp.

CONDENSER LEAKAGE, Recorders
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Leeds & Northrup

CONDENSER TESTERS (See Testers, Condenser)

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Coleman Electric Co.
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Esterline-Angus Co.
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Leeds & Northrup Co.
Natl. Aluminate Corp.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.

CONES, Pyrometric
Accurate Pyrometric Cone
Fish-Schurman Co.
Henderson & Co.
Orton Jr. Ceramic F'd'n

CONES, Slump
Central Scientific Co.
Humboldt Mfg. Co.
Precision Scientific Co.
Riehle Div.

CONNECTORS, Plugs, Clips, Posts, Jacks
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Autocall Co.
Clare & Co.
Eby, Inc.
General Radio Co.
Kellogg Switchboard
Mallory & Co.
Meter Devices Co.
RCA Manufacturing
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CONSTANT SPEED and Frequency Sets
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Elec. Tachometer Corp.
Gaertner Scientific Corp.
General Elec. Co.
Pioneer Instrument
United Cinephone Corp.
Westinghouse Elec. & Mfg.

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Leitz, Inc.
Scherr Co., Inc.

CONTROL DRIVES (See Servo-Motors)

CONTROLS, AUTOMATIC (See Controllers, Automatic)

CONTROLLERS, AUTOMATIC (See also object of Measurement and Control)

"CONTROL" — NOTE —

The following pages deserve close study. Note for example that after numerous "Controllers, Automatic" there are three classes of "Controllers, Manual." Look up also under "Regulators" for many types thus termed by usage. Also "Thermostats" and other commonly-used names of specific-purpose automatic controllers.

As a rule, Automatic Controllers are "instrument-like" while devices known as Controls (preceded by name of application) are simple, single-purpose devices.

CONTROLLERS, AUTOMATIC, Ammonia (See Ammonia Control Equipment)

CONTROLLERS, AUTOMATIC, Beater (See Controllers, Automatic, Consistency)

CONTROLLERS, AUTOMATIC, Boiler Feed
Atlas Valve Co.
Bailey Meter Co.
Fisher Governor
Fischer & Porter
Foster Engg. Co.
Foxboro Co.
Henszey Co.
Kiely & Mueller
Manning, Maxwell&Moore
Mason-Neilan Regulator
(Cont'd)

CONTROLLERS, AUTOMATIC, Boiler Feed
(Cont'd)
McDonnell & Miller
Mercon Regulator Co.
Natural Gas Equipment
Northern Equip. Co.
Republic Flow Meters Co.
Robertshaw Thermostat
Ruggles-Klingemann
Watts Regulator Co.
Wilgus Mfg. Co.

CONTROLLERS, AUTOMATIC, Boiler Water Concentration
Cochrane Corp.
Fischer & Porter
Henszey Co.
Leeds & Northrup Co.
Republic Flow Meters
Manning, Maxwell&Moore

CONTROLLERS, AUTOMATIC, Bulk Material Level
Bin-Dicator Co.
Fuller Co.

CONTROLLERS, AUTOMATIC, Chlorine
Arca Regulators, Inc.
Askania Regulator Co.
Builders-Providence
Everson Mfg. Co.
Fischer & Porter
LaMotte Chemical Prod.
Manning, Maxwell&Moore
National Meter Co.
Rascher & Betzold
Victor Equipment Co.
Wallace & Tiernan

CONTROLLERS, AUTOMATIC, Combustion
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Askania Regulator Co.
Bailey Meter Co.
Brooke Eng. Co.
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CONTROLLERS, AUTOMATIC, Combustion
(Cont'd)
Cambridge Inst. Co.
Cash Co.
Consulting & Engineering
Denver Fire Clay Co.
General Combustion Corp.
General Regulator Corp.
Hagan Corp.
Hays Corp.
Lantz-Phelps Corp.
Leeds & Northrup Co.
Mason-Neilan Reg. Co.
Minneapolis-Honeywell
National Airoil Burner
National Brass Co.
Natural Gas Equipment
Republic Flow Meters
Selas Company

CONTROLLERS, AUTOMATIC, Condensation
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Boylston Co.
Fisher Governor Co.
Friez & Sons
General Regulator Corp.
Manning, Maxwell&Moore
Seely Instrument Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.

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Leeds & Northrup Co.
Manning, Maxwell&Moore

CONTROLLERS, AUTOMATIC, Consistency
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Bristol Co.
D'Este Co.
Foxboro Co.
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Merritt Engr. & Sales
Paprex Co.
Process Controls, Inc.

COMBUSTION CONTROL

All Sizes of Boilers All Types of Firing

Republic-Smoot combustion control systems are designed for all sizes of boilers and all types of fuel firing equipment.

CONSTANT STEAM PRESSURE
Automatically maintains a constant steam pressure by controlling the fuel and air input to the boilers in balance with the boiler load.

EFFICIENT COMBUSTION
Automatically maintains maximum combustion efficiency over entire range of boiler rating, by controlling simultaneously the fuel and air input to boiler in measured proportions and in a fixed ratio.

LOAD DISTRIBUTION
Automatically distributes load equally among all the boilers, or the load can be distributed between the boilers as desired.

WRITE FOR DATA BOOK No. S-21

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AUTOMATIC TEMPERATURE CONTROLS

Cover removed

Model D

APPLICATIONS: A most unlimited for controlling temperatures from —103 to 1400 deg. F.

SPECIAL FEATURES: Adjustable range is unusually large — Adjustment by large knob and dial outside of case — Easy reading 2 in. dial graduated in 100 divisions — Large screw terminals make wiring easy — Positive snap action Micro Switches — Levers rotate on 1/4 or 3/16 pins — No knife edges — Ridged castings — Operating Principle, differential expansion of solids, no liquids or gases to cause trouble — Tubes—suitable alloys for low temperatures, high temperatures, or corrosive conditions. These and other features make the model D

Accurate and Positive

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Automatic Control Systems
for every branch of industry

IN POWER PLANTS FOR—
Boiler combustion control.
Pressure reducing.
Prime mover control.

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Booster control.
Collecting-main pressure control.
Stack-draft control.
Oven fuel gas pressure control.

Askania alone has the Jet Pipe Principle

ASKANIA REGULATOR CO. CHICAGO

For addresses, see pages 82-91

A 24-HOUR RECORD—giving accurate and dependable measurements so vital to efficient and economical operation.

Hays Combustion Meters employ the Orsat principle for measurement of CO_2. Water operated — no moving parts—extreme accuracy coupled with dependable performance.

There is a Hays Combustion Meter to fit every requirement—remote or integral mounting, indicating or recording or both. Write to 925 Eighth Avenue, Michigan City, Indiana, for free catalog.

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COMBUSTION METERS, INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

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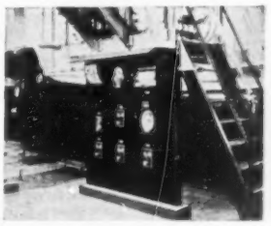
Automatic Controllers

Foxboro makes a comprehensive line of Air- and Electric-Operated Controllers for temperature, pressure, flow, liquid level and humidity. The control systems include every type from the simple Open-and-Shut Control to the Foxboro Stabilog Control System—providing the ideal type of control for every job.

For information concerning the entire line of Foxboro Controllers refer to "Sweet's Catalog," or write for a copy of Bulletin No. 225-1. **The Foxboro Company, 46 Neponset Ave., Foxboro, Mass., U.S.A.** Branch offices in 25 principal cities.



BAILEY METER *Combustion* CONTROL

● Bailey Meter Automatic Combustion Control of boilers results in substantial saving in fuel; increased boiler capacity; reduction of boiler and furnace maintenance; more time for operators to devote to general station maintenance; and improvement in the general character of service.

Bailey Meter Control makes possible the everyday operation of boilers at test efficiencies because it is a complete combustion control system which (1) automatically maintains steam pressure by supplying fuel and air simultaneously to boilers in accordance with changes in steam demand, (2) automatically maintains most economical fuel-air ratio by incorporating the Bailey Boiler Meter as an integral part of the system, (3) automatically maintains the desired furnace draft, and (4) automatically distributes load among boilers so that each unit carries its share.

This sturdy inexpensive air-operated control system has been applied to all sizes and types of boilers ranging from 200 h.p. upward. It is applicable to all fuels and all methods of firing.

For further information consult Sweet's Engineering Catalogs or write for bulletin No. 102-A.

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Bailey Meter Company Ltd., Montreal, Canada

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Eagle Signal Corp.
Lumenite Electric Co.
Manning, Maxwell&Moore
National Time & Signal
Seely Instrument Co.
Standard Electric Time
United Cinephone Corp.

CONTROLLERS, AUTOMATIC, Current (See Regulators)

CONTROLLERS, AUTOMATIC, Cycle
Abrams Instrument
Autocall Co.
Bailey Meter Co.
Barber Coleman
Bristol Co.
Brown Inst. Co.
Cramer & Co., Inc.
Denver Fire Clay Co.
Elec. Switch Corp.
Fisher Governor
Foxboro Co.
Hagan Corp.
Hanlon-Waters, Inc.
Industrial Timer Corp.
Leeds & Northrup Co.
Manning, Maxwell&Moore
Mason-Neilan Reg. Co.
Minneapolis-Honeywell
Monitor Controller Co.
National Time & Signal
Seely Instrument Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.

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Atlas Valve Co.
Bailey Meter Co.
Barber-Coleman Co.
Belfield Co.
Bristol Co.
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Brown Inst. Co.
Cash Co.
Cook Electric Co.
Davis Reg. Co.
Denver Fire Clay Co.
Electronic Prod. Co
Fisher Governor
Foster Eng. Co.
Foxboro Corp.
Friez & Sons, Julien
Gleason-Avery, Inc.
Hagan Corp.
Hanlon-Waters, Inc.
Hays Corp.
Johnson Service Co.
Kiely & Mueller
Leeds & Northrup Co.
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Manning, Maxwell&Moore
Minneapolis-Honeywell
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Natural Gas Equipment
Penn Electric Switch Co.
Powers Regulator Co.
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Ruggles-Klingemann
Schade Valve Mfg. Co.
Spence Eng. Co., Inc.
Tagliabue Mfg. Co.
Taylor Instrument Cos.
Watts Regulator Co.
White-Rodgers Electric
Wilgus Mfg. Co.

CONTROLLERS, AUTOMATIC, Density
Acme Regulator Co.
Arca Regulators, Inc.
Automatic Valve Control.
Lumenite Electric Co.
Manning, Maxwell&Moore
Mine & Smelter Supply
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

CONTROLLERS, AUTOMATIC, Desuperheat
Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Brown Inst. Co.
Foxboro Corp.
Hagan Corp.
Leeds & Northrup Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
Mercon Regulator Co.
Northern Equip. Co.
Republic Flow Meters Co.
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Taylor Inst. Cos.
Trerice Co.

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Bailey Meter Co.
Barber-Coleman Co.
Boiler Room Equip.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Cash Co.
Denver Fire Clay Co.
Foster Eng. Co.
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Gleason-Avery, Inc.
Hagan Corp.
Hays Corp.
Leeds & Northrup Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
Minneapolis-Honeywell
National Airoil Burner
National Brass Co.
Preferred Utilities Mfg.
Republic Flow Meters
Ruggles-Klingemann
Tagliabue Mfg. Co.
Taylor Inst. Cos.

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Belfield Co.
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Fischer & Porter
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Hanlon-Waters, Inc.
Hensley Co.
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Manning, Maxwell&Moore
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McAlear Mfg. Co.
McDonnell & Miller
Mercon Regulator Co.
Natural Gas Equipment
Northern Equip. Co.
Republic Flow Meters
Ruggles-Klingemann
Schade Valve Mfg. Co.
Simplex Valve & Meter
Watts Regulator Co.
Wilgus Mfg. Co.

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Fischer & Porter
International Filter Co.
Manning, Maxwell&Moore
Mason-Neilan Reg. Co.
Taylor Inst. Cos.

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Belfield Co.
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Cash Co.
Cochrane Corp.
Cutler-Hammer, Inc.
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Foxboro Co.
Frick Co.
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Hanlon-Waters, Inc.
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Penn Electric Switch
Powers Regulator Co.
Ruggles-Klingemann
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Tagliabue Mfg. Co.
Taylor Inst. Cos.
Water Level Controls Co.

CONTROLLERS, AUTOMATIC, Flow
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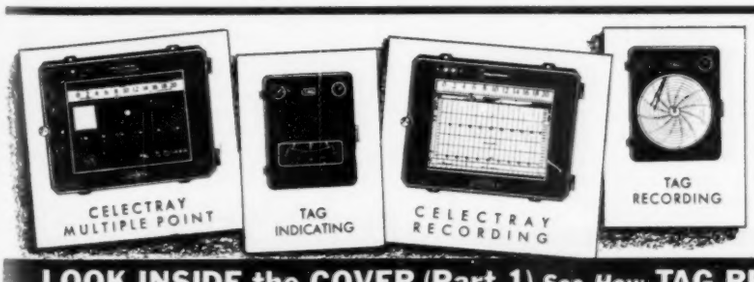
Askania Regulator
Bailey Meter Co.
Bristol Co.
Brooke Engineering
Brown Inst. Co.
Builders-Providence
Cash Co.
Denver Fire Clay Co.
Electrimatic Corp.
Fischer & Porter
Foster Engg. Co.
Foxboro Co.
General Regulator Corp.
Hagan Corp.
Hanlon-Waters, Inc.
International Filter Co.
Leeds & Northrup Co.
Leupold, Volpel & Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator Co.
Northern Equipment
Process Controls, Inc.
Republic Flow Meters
Simplex Valve & Meter
Spence Eng. Co., Inc.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Victor Equipment Co.
Wilgus Mfg. Co.



TAG CONTROLLERS

Wherever the control of plant operations presents a production problem, TAG Automatic Controllers of either the electrical or air-operated types offer competent solution. These TAG Instruments have opened the way to better processing methods by more precise control of temperature, pressure and the time in which they act. Write for catalogs.

C. J. TAGLIABUE MFG. CO.
Park & Nostrand Avenues, Brooklyn, N. Y.

LOOK INSIDE the COVER (Part 1) See How TAG RECORDERS Save You Money TAG

For addresses, see pages 82-91

CONTROLLERS, AUTOMATIC, Flow Proportioning
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Askania Regulator Co.
Autocall Co.
Automatic Temp. Control
Bailey Meter Co.
Barber-Coleman Co.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Builders-Providence
Cash Co.
Cochrane Corp.
Cutler-Hammer, Inc.
Electronic Prod. Co.
Fischer & Porter
Foxboro Co.
General Regulator Corp.
Hagan Corp.
Hanlon-Waters, Inc.
Henszey Co.
Illinois Engr. Co.
International Filter Co.
Lammert & Mann Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator Co.
Republic Flow Meters Co.
Reynolds Gas Regulator
Simplex Valve & Meter
Spence Engr. Co., Inc.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Vergilio Co.
Victor Equipment Co.
Wheelco Inst. Co.

CONTROLLERS, AUTOMATIC, Fluid Proportioning (See Controllers, Automatic, Flow Proportioning)

CONTROLLERS, AUTOMATIC, Frequency (See Regulators)

CONTROLLERS, AUTOMATIC, Furnace
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Arca Regulators, Inc.
Askania Regulator Co.
Automatic Elec. Mfg. Co.
Automatic Temp. Control
Bailey Meter Co.
Barber-Coleman Co.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
(Cont'd)

CONTROLLERS, AUTOMATIC, Furnace (Cont'd)
Cash Co.
Cook Electric Co.
Defender Automatic Reg.
Denver Fire Clay Co.
Dickson Co.
Friez & Sons
Fulton Syphon Co.
General Regulator Corp.
Gleason-Avery, Inc.
Hagan Corp.
Hays Corp.
Industrial Engr. Corp.
Johnston Mfg. Co.
Leeds & Northrup
Lindberg Eng. Co.
Manning, Maxwell&Moore
Marsh Corp.
Mason-Neilan Regulator
McCorkle Co.
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Natural Gas Equipment
Paragon Electric Co.
Partlow Corp.
Payne Furnace & Supply
Penn Electric Switch
Perfex Corp.
Pyrometer Inst. Co.
Republic Flow Meters
Ruggles-Klingemann
Spence Engineering Co.
Spencer Thermostat Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
United Cinephone Corp.
Wheelco Inst. Co.
White Mfg. Co.
White-Rodgers Electric
Wilgus Mfg. Co.

CONTROLLERS, AUTOMATIC, Gas Density
Refinery Supply Co.

CONTROLLERS, AUTOMATIC, Gas Mixing (See Controllers, Automatic, Flow Proportioning)

CONTROLLERS, AUTOMATIC, Granular Material Level
Bin-Dicator Co.

CONTROLLERS, AUTOMATIC, Gravity
Arca Regulators, Inc.
Askania Regulator Co.
(Cont'd)

CONTROLLERS, AUTOMATIC, Gravity (Cont'd)
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Foxboro Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
Mine & Smelter Supply
Tagliabue Mfg. Co.
Taylor Inst. Cos.

CONTROLLERS, AUTOMATIC, Humidity
American Moistening Co.
Arca Regulators, Inc.
Atlas Valve Co.
Barber-Coleman Co.
Brabender Corp.
Bristol Co.
Brown Inst. Co.
Cramer & Co., Inc.
Dietert Co.
Electronic Prod. Co.
Fenwal, Inc.
Foxboro Co.
Friez & Sons
General Controls Co.
H-B Inst. Co., Inc.
Johnson Service Co.
Leeds & Northrup Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
McDonnell & Miller
Minneapolis-Honeywell
Moeller Instrument Co.
Moisture Register Co.
Parks-Cramer Co.
Penn Electric Switch
Phila. Thermometer Co.
Powers Regulator Co.
Robertshaw Thermostat
Sarco Co., Inc.
Scientific Inst. Co.
Seely Instrument Co.
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Taylor Inst. Cos.
Thwing-Albert Inst. Co.
Trerice Co., H. O.
Vaughn-G. F. Witt Co.
Weksler Thermometer

CONTROLLERS, AUTOMATIC, Humidity and Temperature (See Controllers, Automatic, Humidity and Controllers, Automatic, Temperature)

CONTROLLERS, AUTOMATIC, Lighting
Abrams Instrument
Betts & Betts
Cutler-Hammer, Inc.
Paragon Electric Co.
United Cinephone Corp.
Weston Elec. Inst. Corp.
Zenith Electric Co.

CONTROLLERS, AUTOMATIC, Liquid Level
Allen-Bradley Co.
American Meter Co.
Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Autocall Co.
Automatic Control Co.
Automatic Temp. Control
Bailey Meter Co.
Bastian-Blessing Co.
Belfield Co.
Bender Warrick
Bin-Dicator Co.
Boylston Co.
Bristol Co.
Builders-Providence
Brown Inst. Co.
Cash Co.
Cochrane Corp.
Control Corp.
Cutler-Hammer, Inc.
Davis Reg. Co.
Defender Automatic Reg.
Electronic Prod. Co.
D'Este Co.
Elec. Indicator Co.
Fisher Governor Co.
Foster Engg. Co.
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Frick Co.
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Fuller Co.
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General Electric Co.
General Regulator Corp.
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Hagan Corp.
Hanlon-Waters, Inc.
Inferno Co.
International Filter Co.
Johnson Service Co.
Kiely & Mueller
Klipfel Mfg. Co.
Leeds & Northrup Co.
Leupold, Volpel & Co.
Lumenite Elec. Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
McAlear Mfg. Co.
McDonnell & Miller
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Mercon Regulator Co.
Minneapolis-Honeywell
Moore Products Co.
Morey & Jones, Ltd.
Natural Gas Equipment
Northern Equip. Co.
Paragon Electric Co.
Penn Electric Switch
Photoswitch, Inc.
Powers Regulators Co.
Precision Therm.
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Wheelco Inst. Co.
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CONTROLLERS, AUTOMATIC, Load (See Regulators)

CONTROLLERS, AUTOMATIC, Moisture (See Controllers, Automatic, Humidity)

CONTROLLERS, AUTOMATIC, Phase (See Regulators)

CONTROLLERS, AUTOMATIC, Power Factor (See Regulators)

CONTROLLERS, AUTOMATIC, Pressure & Vacuum
Acme Regulator Co.
Allen-Bradley Co.
American Meter Co.
Arca Regulators, Inc.
Askania Regulator Co.
Arca Regulators, Inc.
Atlas Valve Co.
Autocall Co.
Automatic Control Co.
Automatic Temp. Control
Bailey Meter Co.
Baldwin-Southwark Corp.
Bastian-Blessing Co.
(Cont'd)

CONTROLLERS, AUTOMATIC, Pressure & Vacuum (Cont'd)
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Boekel & Co.
Boylston Co.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
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Cash Co.
Connelly Iron Sponge Co.
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Dickson Co.
Eclipse Fuel Engg.
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Foxboro Co.
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McAlear Mfg. Co.
McDonnell & Miller
Mercoid Corp.
Mercon Regulator Co.
Minneapolis-Honeywell
National Time & Signal
Natural Gas Equip. Inc.
Northern Equip. Co.
Penn Electric Switch
Perfex Corp.
Powers Regulator Co.
Precision Therm.
Ranco Inc.
Republic Flow Meters
Reynolds Gas Regulator
Robertshaw Thermostat
Ruggles-Klingemann
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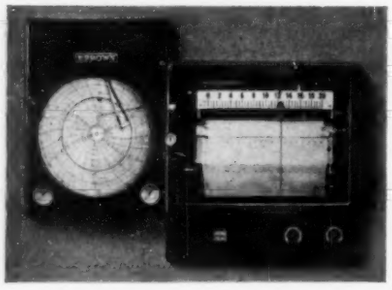

BROWN CONTROLLERS

Electric or Air-Operated Types

Brown instruments are supplied as electric or air-operated controllers, complete with valves, motor mechanisms and relays, for automatically controlling temperatures, pressures, flows, liquid levels, humidity, etc. Instruments indicate or record while they control power plant or industrial processes. Write for Catalog 8903.

Brown Pneumatic Remote Transmission System

For remote transmission of measurement and control of temperatures, pressures, flows and liquid levels in hazardous atmospheres. Write for Catalog 9400.

THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4482 Wayne Avenue, Philadelphia, Pa.

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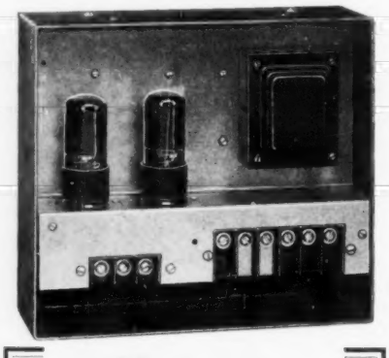
MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS
To Measure and Control is to Economize



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Floatless Non-mechanical

FARATRON LIQUID LEVEL CONTROLS operate on the electronic or radio principle. Liquid, touching or leaving the stainless steel electrode in the container, changes the electronic impulse to activate a distant relay.

Operates in any aqueous liquid at any temperature or pressure. Controls signals or operates pumps and valves. Absolutely automatic—requires no attention.

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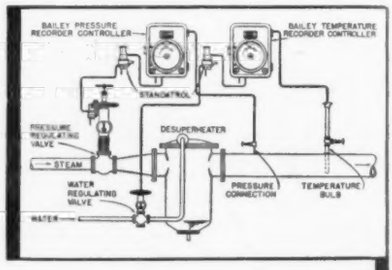


DESUPERHEATING & PRESSURE REDUCING CONTROL

● Bailey Meter Control of desuperheating and pressure reducing incorporates standard Bailey Recorder-Controllers for both pressure and temperature, as well as a special Bailey Reducing Valve equipped with valve positioner and air cooled packing gland.

The control system is air-operated and is arranged to maintain the desired final steam temperature by controlling the quantity of water fed to a cartridge type desuperheater. This temperature is measured by a sensitive bare bulb temperature recorder-controller with the temperature bulb located at the ● outlet of the desuperheater.

BAILEY METER COMPANY
1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

For addresses, see pages 82-91

COMPLETE INSTRUMENTATION

for **INDUSTRIAL PROCESSES**

CONTROLLERS for temperature, pressure, absolute pressure, rate of flow and liquid level. Air-operated potentiometer controllers. Exclusive features resulting in unexcelled performance.

RECORDERS of temperature, pressure, flow level, motion, absolute pressure.

INDICATORS of temperature, pressure, flow and level.

TRANSMISSION SYSTEMS, pneumatic type with exceptionally fast response. Electric signalling systems.

MASONEILAN

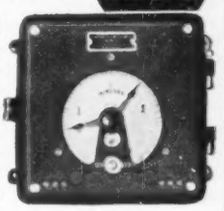
MASON-NEILAN REGULATOR CO.
1185 ADAMS ST., BOSTON, MASS., U. S. A.

Automatic TIMING

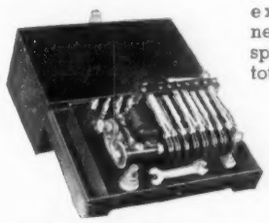
Dependable Control Over Process Periods or Process Actions

...by atc

Accurate control of processes and operations on the basis of TIME, is a major business with ATC. Installations, numbered in the thousands, are daily paying their way with most reliable—therefore most economical—performance. Standard models will start, stop or repeat operations on one to forty load circuits. Adjustment can be exactly what is needed, down to a split second. The total cycle can be seconds or any number of hours.



An ATC Dial Timer available in 40 standard adjustable types



An 8-circuit Cam Timer used to control eight steps of a process

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Representatives in Principal Cities

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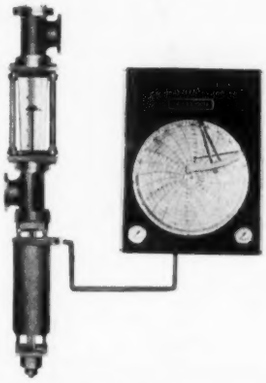
FISCHER & PORTER

ROTA-MATIC



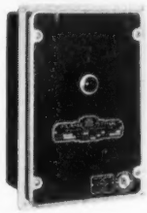
FOR AUTOMATIC CONTROL

The Rota-matic is a fully automatic controlling rotameter. It will maintain a constant flow rate regardless of process lag or continual load changes. The control point may be set at any flow over the entire range of the rotameter. Handles corrosive and viscous fluids which no other controller will handle. Also gives permanent chart record of flow rate and registers total flow.

Send for Bulletin 51-B

FISCHER & PORTER CO.
23 COUNTY LINE ROAD
HATBORO PENNSYLVANIA

Wheelco Flame-otrols Combustion Safeguards



Wheelco Flame-otrols provide positive safety against combustion explosions resulting from flame failure. Flame-otrols also prevent entry of fuel into the combustion chamber until adequate means are provided for establishing ignition.

The Flame-otrol is the only combustion safeguard approved by both Underwriters' Laboratories and Associated Factory Mutual Laboratories for all types of fuel.

Complete description given in Bulletin No. L2-2.
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for

Water Levels and Flow

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Taylor Inst. Cos.
Trerice Co., **H. O.**
Uehling Instrument Co.
Vapor Recovery Systems
Vaughn-G. E. Witt Co.
Victor Equipment Co.
Ward Leonard Elec. Co.
Water Level Controls Co.
Watts Regulator Co.
Waugh Laboratories
Wheelco Inst. Co.
White-Rodgers Electric
Wilgus Mfg. Co.
Wood, Harry W.

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Burling Inst. Co.
Dickson Co.
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Electronic Prod. Co.
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G-M Labs
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Lewis Engg. Co.
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Pyrometer Instrument Co.
Seely Instrument Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thwing-Albert Instrument
Uehling Instrument Co.
Wheelco Inst. Co.

CONTROLLERS, AUTOMATIC, Radio Remote
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Guardian Elec. Mfg. Co.
United Cinephone Corp.

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Cash Co.
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D'Este Co.
Dickson Co.
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Fulton Sylphon Co.
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Lumenite Elec. Co.
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Perfex Corp.
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Tagliabue Mfg. Co.
Taylor Inst. Cos.
White-Rodgers Electric

CONTROLLERS, AUTOMATIC, RKVA (See Regulators)

CONTROLLERS, AUTOMATIC, Specific Gravity (See Controllers, Automatic, Gravity)

CONTROLLERS, AUTOMATIC, Speed (See Tachometric below)

CONTROLLERS, AUTOMATIC, Stoker (See Controllers, Automatic, Furnace)

CONTROLLERS, AUTOMATIC, Strain-Rate & Stress-Rate
Baldwin-Southwark Corp.

CONTROLLERS, AUTOMATIC, Synchronizing (See Regulators)

CONTROLLERS, AUTOMATIC, Tachrometric
Abrams Instrument
Askania Regulator Co.
Bailey Meter Co.
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Cutler-Hammer, Inc.
Foxboro Co.
General Regulator Corp.
Hagan Corp.
Mason-Neilan Regulator
Moisture Register Co.
Monitor Controller Co.
Republic Flow Meters

CONTROLLERS, AUTOMATIC, Temperature (See Pyrometric above or Thermometric below)

CONTROLLERS, AUTOMATIC, Temperature-Time (See Controllers, Automatic Thermometric; Controllers, Automatic, Thermostatic; Controllers, Automatic, Time)

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Burling Inst. Co.
Dickson Co.
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Electrimatic Corp.
Electro-Medical Lab.
Emerson Apparatus Co.
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Friez & Sons
General Elec. Co.
General Regulator Corp.
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H-B Inst. Co., Inc.
Ill. Testing Labs.
Kessler Co.
Lindberg Eng. Co.
Manning, Maxwell&Moore
Marsh Corp.
McAlear Mfg. Co.
Minneapolis-Honeywell
Moeller Instrument Co.
Moisture Register Co.
Paragon Electric Co.
Parks-Cramer Co.
Partlow Corp.
Precision Therm.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trerice Co.
Weksler Thermometer
Wheelco Inst. Co.

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American Inst. Co.
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Barber-Coleman Co.
Boekel & Co.
Bristol Co.
Boiler Room Equip.
Brown Inst. Co.
Burling Inst. Co.
Bushnell & Nevins
Cook Electric Co.
Cramer & Co., Inc.
D'Este Co.
Dickson Co.
Edison Electrical Controls
Ermstat Co.
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Industrial Engr. Corp.
Johnson Service Co.
Kiely & Mueller
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Leslie Co.
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Marsh Corp.
McCorkle Co.
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Minneapolis-Honeywell
Moisture Register Co.
Partlow Corp.
Penn Electric Switch
Perfex Corp.
Phila. Thermometer Co.
Powers Regulator Co.
Precision Therm.
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"Radio Principle" Controllers include:

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Complete data are available on all the above Controllers. Write for your copies, today.

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Bailey FEED WATER Control

● Bailey Meter Company offers three distinct feed water control systems. They are (1) the Thermo-hydraulic Feed Water Regulator which is suitable for the majority of small boilers operating at relatively low pressures. This regulator operates from water level alone and is provided with a fully balanced tight seating V-port regulating valve designed to give a straight line characteristic. It offers the advantages of low installation cost, removable valve parts and independence of valve location.

(2) The Single-Element air-operated feed water control system is recommended for installations on which smooth regulation of feed water flow is desired, and a wide regulating range cannot be used. This system is controlled by water level alone as measured by a Bailey Boiler Drum Water Level Recorder.

(3) Bailey Three-Element feed water control is recommended for high capacity low water storage boilers operating at high pressures or for boilers operating at medium pressures with violent load fluctuations. This system is based on actual measurement of water flow to the boiler, steam flow from the boiler and water level within the boiler, and is adjusted primarily to control the rate of water flow to the boiler so that it equals the rate of steam flow from the boiler.

For detailed information consult Sweet's Engineering Catalogs or request bulletin ● No. 105-A.

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1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

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SOLENOID VALVES

SUITABLE FOR ALL SERVICES
HANDLE LIQUIDS, GASES, VAPORS AND REFRIGERANTS

TYPE K-15—Pilot piston operated for low and high pressure duty on air, gas, water, light oil and all refrigerants.

TYPE K-10—Magnetic valves for controlling light and heavy oils, water, air, gas, steam, ammonia.

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BRANCH OFFICES: BOSTON • NEW YORK • PHILADELPHIA
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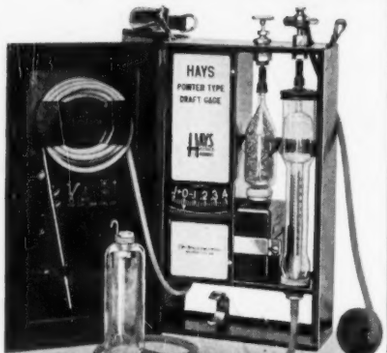
A LABORATORY JOB DONE IN THE FIELD



HAYS PORTABLE COMBUSTION TEST SETS are equipped to handle an accurate gas analysis—right in the field.

Installations become more successful, troublemakers are rapidly exposed, guesswork becomes a thing of the past.

Test Sets are available with all necessary equipment for the analysis for CO_2, CO, and O_2—complete with flue gas thermometer, and draft gage. For further particulars—write to 925 Eighth Avenue, Michigan City, Indiana.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

For addresses, see pages 82-91

QUALITY **EBY** PRODUCTS

ARE STANDARD WITH

The U. S. Army & Navy!

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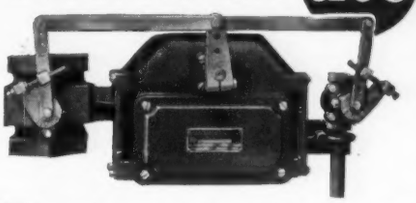
MOTOR-OPERATED CONTROLLERS

... by atc

For automatic control of Temperature, Level, Pressure, Flow



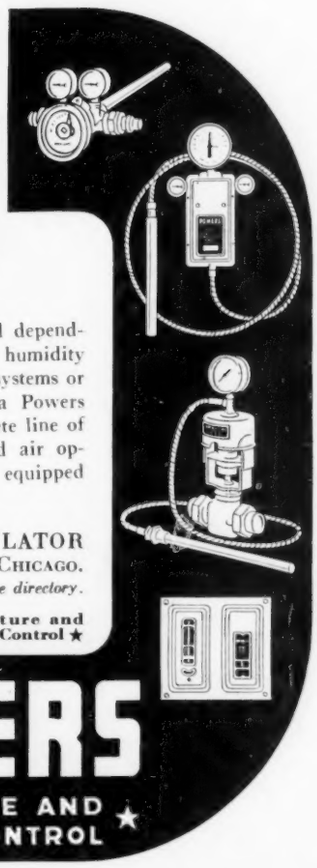
ATC manufactures the broadest line of valve-control mechanisms, standard types ranging from the simplest "off-on" control to fully balancing of the medium against the demand at any moment. Thousands now in use are demonstrating their accuracy, ruggedness and dependability. All models are easily installed from instructions accompanying shipments. Illustrated is the ATC RELATROL which provides compensating valve positions in direct relation to deviation from the control setting. To show sturdiness and simplicity two views are shown; the upper a front view with two valves, the lower a back view with heavy protective cover removed. Ask about ATC before specifying any valve-control devices.

SEND for CATALOG A-2

which describes the various standard units

Representatives in Principal Cities

AUTOMATIC TEMPERATURE CONTROL CO.
25 E. Logan St. Philadelphia, Pa.



When you want accurate and dependable automatic temperature or humidity control for Air Conditioning systems or Industrial Processes call in a Powers engineer. With a very complete line of self-operating and compressed air operated controls we are well equipped to fill your requirements.

THE POWERS REGULATOR CO., 2734 Greenview Ave., CHICAGO.
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50 Years of Temperature and ★ Humidity Control ★

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★ TEMPERATURE AND HUMIDITY CONTROL ★

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TESTED TO 4000 LBS.

This is a lubricated Cock. Body is made of forged steel. The plug is Stainless Steel. Rated for 2000 lbs. working pressure and tested to 4000 lbs. Use this tightly sealed Cock on all gauge lines, instrument panel hook-ups, etc. Quarter turn completely opens or closes. Ask for Bulletin.

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Edison Electrical Prods.
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Fisher Governor
Foxboro Co.
Friez & Sons, Julien
General Elec. Co.
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Industrial Timer Corp.
Johnson Service Co.
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Luers, J. Milton
Manning, Maxwell&Moore
Mason-Neilan Regulator
Minneapolis-Honeywell
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Northwestern Clock Co.
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Penn Electric Switch
Perfex Corp.
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Photovolt Corp.
Powers Regulator Co.
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Rhodes, Inc., M. H.
Sangamo Elec. Co.
Seely Instrument Co.
Stromberg Electric Co.
Struthers-Dunn
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thomas Clock Co., Seth
Tork Clock Co.
United Cinephone Corp.
Wadsworth Elec. Mfg.
Walser Automatic Timer
Ward Leonard
Zenith Electric Co.

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(See Controllers, Automatic, Pressure)

CONTROLLERS, AUTOMATIC, Valve (See Valve-Operating Devices)

CONTROLLERS, AUTOMATIC, Viscosity
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Bailey Meter Co.
General Elec. Co.
Paprex Co.
Scientific Inst. Co.
United Cinephone Corp.

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CONTROLLERS, AUTOMATIC, Volume (See Controllers, Automatic, Flow)

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National Elec. Controller
Schaefer Bros. Co.
Ward Leonard Elec. Co.
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Hydraulic Controls

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General Elec. Co.
Monitor Controller Co.
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Schaefer Bros. Co.
Superior Electric Co.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.

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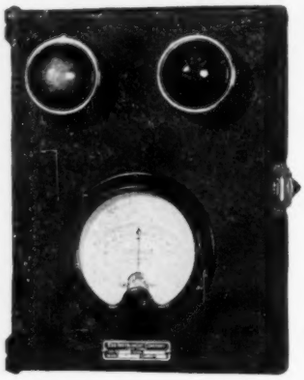
Beck Bros.
Cutler-Hammer, Inc.
Elec. Controller & Mfg.
General Elec. Co.
Monitor Controller Co.
National Elec. Controller
Ohmite Mfg. Co.
Rubicon Co.
Schaefer Bros. Co.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.

CONTROL SYSTEMS (See Controllers, Automatic)



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Thomas Co., Arthur H.

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Paragon Electric Co.
Raytheon Mfg. Co.
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Southwestern Electronics
Standard Elec. Time Co.
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Saxl Inst. Co.
Southwestern Electronics
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United Cinephone Corp.
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Cambridge Inst. Co.
Geophysical Instrument
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Welch Mfg. Co.

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General Elec. Co.
Ohmer Register Co.
Paragon Electric Co.
Southwestern Electronics
United Cinephone Corp.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

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Keuffel & Esser Co.
McDonnell Odometer Co.
Moisture Register Co.
Tally-Meter Co.

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Lumenite Electric Co.
Paver-Sills Co.
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United Cinephone Corp.
Weston Electrical Inst.

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Richardson Scale Co.
Rowe Radio Research
Shallcross Mfg.
Struthers-Dunn
United Cinephone Corp.
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Bristol Co.
Boulin Instrument Corp.
Cummings Machine Wks.
Durant Mfg. Co.
Elec. Tachometer Corp.
Elgin National Watch
Gurley, W. & L. E.
Hart Mfg. Co., R. E.
Ideal Commutator Dresser
Jaeger Watch Co.
Jones Motrola Sales Co.
Knopf, Paul
Marsh Corp., Jas. P.
Mason-Neilan Regulator
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COUNTERS, Revolution
(Cont'd)
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McNab of Bridgeport
Moisture Register Co.
Ohmer Register Co.
Production Inst. Co.
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Southwestern Electronics
Speidel & Co.
Standard Elec. Time Co.
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Starrett Co., L. S.
Veeder-Root, Inc.
Warren-Knight Co.
Zernickow Co., O.

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Bristol Co.
Clay-Adams Co.
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Eagle Signal Corp.
Guardian Elec. Mfg. Co.
Hart Mfg. Co., R. E.
International Register Co.
McDonnell Odometer Co.
Moisture Register Co.
Photobell Corp.
Ohmer Register Co.
Production Inst. Co.
Southwestern Electronics
United Cinephone Corp.
Veeder-Root, Inc.

COUNTERS, Twist
McDonnell Odometer Co.
Saxl Instrument Co.
Scott Co., Henry L.
Southwestern Electronics
Suter, Alfred
Veeder-Root, Inc.

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Bliley Electric Co.
Brush Development Co.
General Radio Co.
Premier Crystal Labs.
RCA Manufacturing Co.
Valpey Crystals
Zeiss, Inc., Carl

CRYSTALS, Quartz
Bliley Electric Co.
Fuess, Inc.
General Radio Co.
Master Optical Co.
Premier Crystal Labs.
RCA Manufacturing Co.
Valpey Crystals

CRYSTALS, Rochelle Salt
Brush Development Co.

CRYSTALS, Tourmaline
Fuess, Inc.
Premier Crystal Labs.
Zeiss, Inc., Carl

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General Elec. Co.
Monitor Controller Co.
RCA Manufacturing

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CURRENT REGULATORS (See Regulators, Current)

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Coats Mach. Tool Co.
McDonnell Odometer Co.
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CYCLE COUNTERS (See Counters, Cycle)

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DECIBEL METERS (See Sound Level Meters)

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Dietert Co.

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DEMAND, Recorders (See Meters, Demand)

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Baird Associates
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DENSOMETERS
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Gaertner Scientific Corp.
Gurley, W. & L. E.
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Federal Prod. Corp.
Gen. Engg. & Model Wks.
Starrett Co.

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DEPTH INDICATORS, Sea
Moeller Inst. Co.

DEPTH, Recorders, Liquid (See Gages, Liquid Level, Indicating)

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Davis Emergency Equip.
Mine Safety Appliances

DETECTORS, Carbon Monoxide
Mine Safety Appliances

DETECTORS, Gas
Heiland Research

DETECTORS, Hydrogen Cyanide
Mine Safety Appliances

DETECTORS, Hydrogen Sulphide
Mine Safety Appliances

DETECTORS, Mercury Vapor
Mine Safety Appliances

DETECTORS, Metal
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Geophysical Inst. Co.
Ill. Testing Labs.
Luxtrol Co., Inc.
McFarlin Co.
RCA Manufacturing Co.
United Cinephone Corp.

DETECTORS, Methane
Davis Emergency Equip.
Heiland Research
Mine Safety Appliances

DETECTORS, Mine Gases
Bushnell & Nevins
Heiland Research
Mine Safety Appliances

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Mineraliac Electric Co.

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Gen. Engg. & Model Wks.
Premier Crystal Labs.
Scherr Co., Geo.
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Ferner Co.
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Rockwell Co., Stanley P.
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Muter Company
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Sensitive Research Inst.
Shallcross Mfg. Co.
Televiso Co.
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Zeiss, Inc., Carl

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Brown & Sharpe
Gaertner Scientific Corp.
Hayes Scientific Apps.
Mico Instrument Co.
Precise Instrument Co.

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DRAFT Controllers (See Controllers, Automatic Draft)

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Dietzen Co.
Drafto Co.
Gurley, W. & L. E.
Henschel & Co.
Kern Co.
Keuffel & Esser Co.
Millers Falls Co.
Nelson Section Liner
Post Co., Frederick
Soltmann, Inc., E. G.
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Pfaltz & Bauer, Inc.
Sargent & Co.
Scientific Glass Apparatus
Scientific Inst. Co.
Willson Products, Inc.
Zeiss, Inc., Carl

DYNAMOMETERS, Hydraulic
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DYNAMOMETERS, Pull Rod
Hathaway Inst. Co.
Hayes Scientific Apps.
Martin Decker Corp.
Seederer-Kohlbusch, Inc.

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Bristol Co.
General Elec. Co.
L. A. B. Corp.
Mid-West Dynamometer

DYNAMOMETERS, Tension
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Boulin Instrument Corp.
Dillon & Co.
Hathaway Inst. Co.
Olsen Testing Machine
Riehle Div.
Seederer-Kohlbusch
Thwing-Albert

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Hathaway Instrument
Rubicon Co.
Seederer-Kohlbusch

EARTH CURRENT METERS (See Meters, Earth Current)

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Geophysical Inst. Co.
Heiland Research
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Shallcross Mfg.
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Central Scientific Co.
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Precision Therm.
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General Radio Co.
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Central Scientific Co.
Pfaltz & Bauer, Inc.
Rubicon Co.
Testrite Instrument Co.
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ELECTROMETERS, String
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Geophysical Inst. Co.
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ENGINE INDICATOR REDUCING MOTION (See Reducing Motion, Engine Indicator)

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Eimer & Amend
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EUSCOPES
Bausch & Lomb Optical

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Brabender Corp.
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Leeds & Northrup Co.
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Richardson Scale Co.
Triangle Package Mach.

FILLING MACHINES, Barrel
Bowser & Co.

FILLING MACHINES, Can
Anderson Bros. Mfg.
Bowser & Co.
Gump Co., B. F.
Triangle Package Mach.

FILLING MACHINES, Carton
Gump Co., B. F.
Triangle Package Mach.

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Bausch & Lomb Opt.
Central Scientific Co.
Corning Glass Works
Fish-Schurman Co.
Fuess, Inc.
Kollmorgen Optical Co.
Leitz, Inc.
Perkin-Elmer Corp.
Zeiss, Inc., Carl

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Bausch & Lomb Optical
Electronic Laboratory
Fecker, J. W.
Fish-Schurman
General Scientific Corp.
Goerz Amer. Optical Co.
Klett M'g. Co.
Mico Instrument Co.
Pfaltz & Bauer, Inc.
Rubicon Co.
Testrite Instrument Co.
Triumph Mfg. Co.
United Cinephone Corp.

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Fecker, J. W.
Kern Co.
Kollmorgen Optical Co.
Unertl Opt. Co.
United Cinephone Corp.

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Veritas Firing System

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Bacharach Industrial Inst.
Betts & Betts
Paragon Electric Co.
Sangamo Electric Co.

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Bausch & Lomb Optical
Clark & Sons
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Fuess, Inc.
Gaertner Scientific Corp.
Goerz Amer. Optical Co.
Kollmorgen Optical Co.
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Mico Instrument Co.
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Perkin-Elmer Corp.
Ruska & Co.
Scherr Co., Inc., George
(Cont'd)

FLATS, OPTICAL (Cont'd)
Simpson Optical
Spencer Lens
Tinsley Laboratories
Unertl, John
Van Keuren Co.
Wilder, R. S.
Woermann-Schuchhardt
Zeiss, Inc., Carl

FLATS, OPTICAL, Fused Quartz
Bausch & Lomb Opt.
Thermal Syndicate Ltd.

"FLOW"

(Flowmeters measure primarily RATE of flow. For positive or "quantity" fluid meters, see the numerous classes under "Meters")

FLOWMETERS, AIR (See Flowmeters, Gas)

FLOWMETERS, AREA Cone & Disk Type
Cochrane Corp.
Commercial Engg. Labs.
Fischer & Porter
Friez & Sons
National Meter Co.

FLOWMETERS, AREA Cylinder & Piston Type
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Bowser & Co.
Brown Inst. Co.
Fischer & Porter
National Meter Co.
New Jersey Meter Co.

FLOWMETERS, AREA Free Float Type
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D'Este Co.
Fischer & Porter
Fish-Schurman Corp.
Hoke, Inc.
Schutte & Koerting Co.

FLOWMETERS, AREA Orifice & Plug Type
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Bacharach Industrial Inst.
Brown Inst. Co.
Cochrane Corp.
Fischer & Porter
Mason-Neilan Regulator
Republic Flow Meters
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, BLAST (See Flowmeters, Gas)

For addresses, see pages 82-91

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Liquid Level • Weight

VENTURI

Builders Venturi Meter is equally respected in boiler rooms, water works, and sewage disposal plants everywhere. For the super-accuracy required by central stations, each Type M is adjusted to match exactly its University-calibrated Venturi Tube. Write for Bulletin 324.

CHRONOFLO

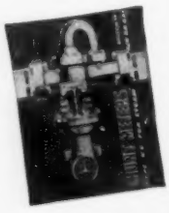
Builders Chronoflo Telemeter brings measurements of flow, level, pressure, temperature, and weight from any distance to centrally located indicating and recording instruments. The Chronoflo time impulse Meter has more than fulfilled its promise. Write for Bulletin 320A.

FLO-WATCH

An attractive flow meter as accurate as it is good-looking. This recording, indicating, and totalizing meter is designed and priced to allow wide use throughout the plant. Equally serviceable with Venturi Tube, Flow Nozzle or Orifice Plate. Write for Bulletin 318A.

SHUNT

Again and again, hundreds of firms have purchased Builders Shunt Meters to measure steam, air, or gas that they sell to customers or distribute to various departments. Low price and accuracy are but two of the many Type KS advantages. Write for Bulletin 307.



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Builders-Providence
Clark Blast Meter
Cochrane Corp.
Commercial Engg. Labs.
D'Este Co.
Detroit Air Meter Co.
Eclipse Aviation
Elec. Indicator Corp.
Fischer & Porter
Fish-Schurman Co.
Foxboro Co.
Friez & Sons
Gas Appliance Specialties
Henszey Co.
Hoke, Inc.
Ill. Testing Labs.
International Filter Co.
Kollsman Inst. Co.
Lambert Meter Co.
Leeds & Northrup
Leupold, Volpel & Co.
Mason-Neilan Regulator
Meriam Co.
Morey & Jones, Ltd.
National Meter Co.
New Jersey Meter Co.
Pioneer Instrument
Republic Flow Meters
Ring Balance Co.
Schutte & Koerting Co.
Scientific Glass Apparatus
Selas Company
Simplex Valve & Meter
Spray Engg. Co.
Superior Meter Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trimount Instrument
Victor Equipment Co.

FLOWMETERS, LIQUID
(See Flowmeters, Gas)

FLOWMETERS, Open-Stream
Bristol Co.
Builders-Providence
Cochrane Corp.
Leupold, Volpel & Co.
Mason-Neilan Regulator
Morey & Jones, Ltd.
Republic Flow Meters
Scientific Inst. Co. Calif.
Simplex Valve & Meter

FLOWMETERS, Orifice, and Nozzle
Ace Glass Inc.
American Meter Co.
Askania Regulator Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Cochrane Corp.
Commercial Engg. Labs.
Corning Glass Works
Elmer & Amend
Fischer & Porter
Foxboro Co.
Hoke, Inc.
Lambert Meter Co., Inc.
Leeds & Northrup Co.
Leupold, Volpel & Co.
Mason-Neilan Regulator
Meriam Co.
Morey & Jones, Ltd.
Permutit Co.
Pgh. Equitable Meter
Republic Flow Meters
Ring Balance Co.
Ruska & Co., Inc.
Scientific Glass Apparatus
Scientific Inst. Co.
Simplex Valve & Meter
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, Pitot Tube
Am. Blower Corp.
American Meter Co.
Askania Regulator Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Bristol Co.
Builders-Providence
Cambridge Inst. Co.
Central Scientific Co.
Cochrane Corp.
Defender Automatic Reg.
Detroit Air Meter Co.
Foxboro Co.
Friez & Sons
Fuess, Inc.
Kollsman Inst. Co.
Leupold, Volpel & Co.
Meriam Co.
Morey & Jones, Ltd.
Pitometer Log Corp.
Precision Therm. & Inst.
Refinery Supply Co.
Republic Flow Meters
Ring Balance Co.
Simplex Valve & Meter
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, Steam
Am. Dist. Steam Co.
American Meter Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Cochrane Corp.
Fischer & Porter
Foxboro Co.
Leeds & Northrup Co.
Mason-Neilan Regulator
Meriam Co.
Morey & Jones, Ltd.
Republic Flow Meters
Ring Balance Co.
Simplex Valve & Meter
Tagliabue Mfg. Co.
Taylor Inst. Cos.

FLOWMETERS, Vane
Autocall Co.
Detroit Air Meter Co.
Friez & Sons
Ill. Testing Labs.
Mason-Neilan Reg. Intn.
Simplex Valve & Meter

FLOWMETERS, Venturi Type
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Cochrane Corp.
Foxboro Co.
International Filter Co.
Leupold, Volpel & Co.
Mason-Neilan Regulator
Morey & Jones, Ltd.
Republic Flow Meters
Ring Balance Co.
Simplex Valve & Meter
Taylor Inst. Cos.

FLOWMETERS, Weir
Bailey Meter Co.
Binckley, G. S.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Cochrane Corp.
Elec. Indicator Corp.
Foxboro Co.
Gurley, W. & L. E.
Leupold, Volpel & Co.
Mason-Neilan Regulator
Morey & Jones, Ltd.
Simplex Valve & Meter
Taylor Inst. Cos.

FLUE GAS ANALYZERS
(See Gas Analyzers, Flue Gas)

FLUID METERS, GAS
(See Gas Meters)

For addresses, see pages 82-91

FISCHER & PORTER

Hevi-Duty Rotameter

FOR CORROSIVE FLUIDS

The Hevi-Duty rotameter is adaptable for measuring flow rates of a wide variety of corrosive fluids. It may be constructed of such corrosion-resistant materials as stainless steel, hard lead, rubber, ceramics, Duriron, Hastelloy, Haveg, Karbate and many others.

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Send for Bulletin 20-B

FISCHER & PORTER CO.
23 COUNTY LINE ROAD
HATBORO PENNSYLVANIA

FLOW METERS

● The Type H illustrated is an extremely accurate indicating instrument for measuring the flows of gases or liquids when operating pressures do not exceed 250 lbs. per sq. in. and the differential pressure does not exceed 160 inches of water pressure. Wall or Panel Mounting. Direct reading scales to meet any requirement. Also Inclined Tube types—for low differential ranges of 25″ or 49″ of water. Fully descriptive catalog sent on request.

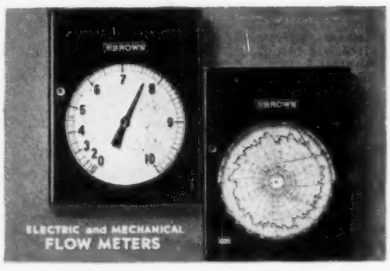
THE MERIAM CO.
CLEVELAND, OHIO

Manometers, Meters, and Gauges for the accurate measurement of Pressures, Vacuums and Flows of Liquids and Gases.

FOXBORO METERS

A complete line of Flow Meters for steam, gas, air, oil, water, acids and other fluids. Orifice type – simple in design, powerful, with a straight-line motion that assures permanent calibration, long life. Can be furnished with integrator to give total flow. Recorders may also be equipped with pressure, temperature and integrator pens.

Write for Bulletin Nos. 200-5 and 692. The Foxboro Company, 46 Neponset Avenue, Foxboro, Mass., U. S. A.



For Controlling, Recording, Totalizing and Indicating the Flow of Fluids such as Steam, Water, Gas, Oil, etc.

Brown Flow Meters are available in two types, the Electric type and Mechanical type.

ELECTRIC TYPE: Complete equipment consists of three units, the orifice plate, manometer and instrument. Instrument can be located at a remote point from the orifice and manometer (point of flow measurement).

Because of this flexibility, it is particularly adaptable for applications where instruments are to be remotely located. Write for Catalog 2007.

MECHANICAL TYPE: Complete equipment consists of two units, the orifice plate and the instrument. The meter body is integral with the instrument. Readings are transmitted mechanically from meter body to instrument. Write for Catalog 2204.

THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4482 Wayne Avenue, Philadelphia, Pa.

BROWN FLOW METERS
AND
MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS
To Measure and Control is to Economize

BAILEY
Fluid Meters

For STEAM · LIQUIDS · GASES

● Bailey Fluid Meters are designed to indicate, record and integrate the flow of steam, liquids, or gases under practically any pressure or temperature condition.

A great variety of indicating, recording and integrating combinations are available for use with four distinct types of flow mechanisms.

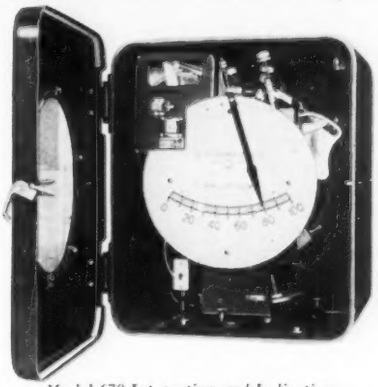
This large variety of possible combinations enables the flow meter engineer to specify equipment which is pre-eminently suited to any flow measuring application.

When it is desired to place indicators, recorders and integrators at a considerable distance from the primary element, Bailey Synchro-Meters are available to provide electric transmission.

For detailed information consult Sweet's Engineering Catalogs or request a copy of bulletin No. 301.

BAILEY METER COMPANY
1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

FLOW METERS FOR ALL PURPOSES



Model 670 Integrating and Indicating Flow Meter

★

HIGH PRESSURE METERS
Standard Differential Range—20″ to 150″ Water

LOW PRESSURE METERS
Standard Differential Range—1″ to 8″ of Water

★

Range Change Can be Made Without Taking Meter Out of Service

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Write for Bulletin 410

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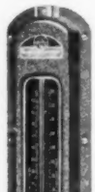
LIQUID MEASUREMENT
with the
KING-GAGE
(formerly Industrial K-S Telegage)

A simple hydrostatic balance — no floats, gears, diaphragms or moving parts — rugged construction — simple design — accurate measurement of Laboratory standard for commercial use. Distant reading, for indicating contents of pressure or vented storage tanks in any unit of Depth, Volume or Weight.

Approved by Underwriters' Laboratories

KING ENGINEERING CORP.
ANN ARBOR, MICH.



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BELLOWS ACTUATED
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and
LIQUID LEVEL
GAUGES
of the
DIFFERENTIAL
PRESSURE TYPE

Other Instruments Manufactured Include

The NOZZLE PRESSURATER
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HIGH PRES. TYPE

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MOREY & JONES, LTD.
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FLOW METERS

For Measuring the Flow of Steam-Water-Gas-Air-Oil

WORKING PRESSURES
Republic meters are available for all working pressures up to 5000 lb. per sq. in.

RANGE EASILY CHANGED
The range of a Republic meter can be easily and quickly changed by merely changing the range tube.

READING INSTRUMENTS
The Republic indicator, recorder and integrator operate independently of each other and can be supplied separately or in combination. They are remote reading.

EASILY READ
The indicator scale and the recorder chart all have uniform graduations and are direct reading. The integrator has a large cyclometer type dial.

WRITE FOR DATA BOOK No. 701

REPUBLIC FLOW METERS CO.
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VACUUM GAUGES
(PIRANI TYPE)

Shown at left is meter box of our model No. 6 gauge.

This gauge successfully used by many of America's foremost manufacturers.

Send for circular on our new low priced D.C. operated gauge.

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GENEVA, ILLINOIS

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FLUID METERS, QUANTITY (See Gas Meters; Meters, Current; Meters, Liquid)

FLUORESCENT CHEMICALS
Central Scientific Co.
Pfaltz & Bauer, Inc.
Patterson Screen Co.
Laboratory Specialties

FLUORESCENT MERCURY VAPOR TUBES EMITTING WHITE LIGHT (See Light Sources)

FLUOROSCOPES
General Electric X-Ray
Patterson Screen Co.
Westinghouse X-Ray Co.

FLUXMETERS
Annis Co.
Cambridge Inst. Co.
Central Scientific Co.
General Elec. Co.
Leeds & Northrup Co.
Rawson Electrical Inst.
Rubicon Co.
Sensitive Research Inst.

FOLDING ENDURANCE TESTERS (PAPER) (See Testers, Folding Endurance)

FOOT BLOCKS
Ford Motor Co.

FOOT CANDLE METERS
Central Scientific Co.
De Jur-Amsco Corp.
General Elec. Co.
G-M Labs.
Pfaltz & Bauer, Inc.
Photovolt Corp.
United Cinephone Corp.
Weston Elec. Inst. Corp.

FOREWARN DETECTOR, for locating hidden weapons (See Detectors, Metal)

FORKS, Synchronization
Elec. Tachometer Corp.
Gaertner Scientific Corp.
Riverbank Laboratories

FORKS, Tuning
Clay-Adams Co.
Hathaway Instrument

FORKS, Tuning, Electrically Driven
American Inst. Co.
Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
Elec. Tachometer Corp.
Engineering Labs., Inc.
Gaertner Scientific Corp.
General Radio Co.
Hathaway Inst. Co.
Riverbank Laboratories
Welch Mfg. Co.

FORKS, Vacuum Driven
Cambridge Inst. Co.
Gaertner Scientific Corp.
Riverbank Laboratories

FRACTIONAL HORSEPOWER MOTORS (See Motors, Fractional Horsepower)

FREENESS TESTERS (See Testers, Freeness)

FREQUENCY METERS, Controlling
Doolittle Radio
General Elec. Co.
Leeds & Northrup Co.

FREQUENCY Meters, Electronic
De Jur-Amsco Corp.
General Radio Co.
RCA Manufacturing Co.

FREQUENCY METERS, Indicating
General Elec. Co.
General Radio Co.
Hathaway Instrument
Hickok Elec. Inst. Co.
J-B-T Instruments
Leeds & Northrup Co.
RCA Manufacturing Co.
Roller-Smith Co.
Sensitive Research Inst.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

FREQUENCY METERS, Recording
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Esterline-Angus Co.
General Elec. Co.
Leeds & Northrup Co.
Roller-Smith Co.
Warren Telechron Co.
Westinghouse Elec. & Mfg.

FREQUENCY METERS, Standards
Bliley Electric Co.
Doolittle Radio
Ferris Inst. Corp.
Hathaway Instrument
Millen Mfg. Co.
RCA Manufacturing Co.

FREQUENCY METERS, Vibrating Reed
Biddle Co., Jas. G.

FRITTED GLASS FILTERS & APPARATUS
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Fish-Schurman Co.
Pfaltz & Bauer, Inc.

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Central Scientific Co.
Eimer & Amend
Machlett & Son
Parr Instrument Co.
Precision Scientific Co.
Sargent & Co.
Tagliabue Mfg. Co.

FUEL FLOW INDICATORS
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Autocall Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Commercial Eng. Labs.
Eclipse Aviation
Fischer & Porter
Foxboro Co.
Mason-Neilan Regulator
National Airoil Burner
Pioneer Instrument
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Victor Equipment Co.

FURNACE CONTROL SYSTEMS (See Controllers, Automatic)

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Kewaunee Mfg. Co.
Kimball Co., W. W.
Laboratory Const. Co.
Laboratory Furniture Co.
Moline Furniture Works
Sheldon & Co.
Sjostrom Co.
Southern Desk Co.
Welch Mfg. Co.

FUSES, INSTRUMENT
Littelfuse Labs.
Meter Devices Co.

GAGE BLOCKS
Ford Motor Co.
Illinois Tool Works
Pratt & Whitney
Scherr Co., George
Standard Gage Co.
Van Keuren Co.

GAGE GLASS ILLUMINATORS
Wright-Austin Co.

GAGE TESTERS, Deadweight
American Inst. Co.
Amthor Testing Inst. Co.
Ashton Valve Co.
Crosby Steam Gage Co.
Manning, Maxwell & Moore
Olsen Testing Machine
Pioneer Instrument
Refinery Supply Co.
Star Brass Mfg. Co.

GAGE TESTERS, Fluid-scale
Crosby Steam Gage Co.

GAGE TESTERS, Liquid-column
Manning, Maxwell & Moore
Pioneer Instrument

GAGES (See also object of Measurement and control)

GAGES, Absolute Pressure
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Clapp Instrument
Foxboro Co.
Kollsman Inst. Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
Moeller Instrument Co.
Pioneer Instrument
Precision Therm.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Uehling Instrument Co.
United States Gauge Co.
Victor Equipment Co.

GAGES, Air
Ashton Valve Co.
Bailey Meter Co.
Bastian-Blessing Co.
Bristol Co.
Clapp Instrument
Detroit Air Meter Co.
Electric Auto-Lite
Foxboro Co.
Friez & Sons
Lambert Meter Co. Inc.
Manning, Maxwell & Moore
Marsh Corp.
Mason-Neilan Regulator
Rochester Mfg. Co.
Star Brass Mfg.
Tagliabue Mfg. Co.
Trerice Co.
Uehling Inst. Co.
U. S. Gage Co.
Victor Equipment Co.

For addresses, see pages 82-91

GAGES, Alarm
Ashton Valve Co.
Bailey Meter Co.
Bristol Co.
Crosby Steam Gage
Foxboro Co.
Manning, Maxwell & Moore
Marsh Corp.
Mason-Neilan Regulator
Precision Therm. & Inst.
Star Brass Mfg.
Trerice Co.
U. S. Gage Co.

GAGES, Amplifying
Coats Mach. Tool Co.
Comtor Co.
Federal Prod. Corp.
Precision Gage & Tool
Saxl Instr. Co.
United Cinephone Corp.

GAGES, Automatic Sorting
Electric Sorting Machine
Hathaway Instrument
Heyman Co.
Instrument Specialties Co.
Rowe Radio Research

GAGES, Bore
Brown & Sharpe
Comtor Co.
Federal Prod. Corp.
Pratt & Whitney
Scherr Co.
Sheffield Gage

GAGES, Bourdon
Ashton Valve Co.
Bailey Meter Co.
Baldwin-Southwark Corp.
Bastian-Blessing Co.
Belfield Co.
Bristol Co.
Brown Inst. Co.
Clapp Instrument
Crosby Steam Gage
Dickson Co.
Electric Auto-Lite
Foxboro Co.
Hays Corp.
Heise Bourdon Tube
Hoke, Inc.
Improved Gauge Mfg.
Manning, Maxwell & Moore
Marsh Corp.
Mason-Neilan Regulator
Mercoid Corp.
Pioneer Instrument
Republic Flow Meters
Star Brass Mfg. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trerice Co.
United States Gauge Co.

GAGES, Caliper (Dial)
Brown & Sharpe
Federal Prod. Corp.
Glogau & Co.
Starrett Co.

GAGES, Center
Lufkin Rule Co.
Millers Falls Co.
Starrett Co.
Union Tool Co.

GAGES, Comparator
Ames Co., B. C.
Coats Mach. Tool Co.
Comtor Co.
Federal Prod. Corp.
Gaertner Scientific Corp.
General Engg. & Model
Hathaway Instrument
Instrument Specialties Co.
Jones & Lamson Machine
Pratt & Whitney
Precision Gage & Tool
Saxl Inst. Co.
Scherr Co.
Sheffield Gage
United Cinephone Corp.

GAGES, Compression
Bacharach Indus. Inst.
G. M. Co. Mfg.
Riehle Div.
Saxl Inst. Co.
Toledo Scale Co.
United States Gauge Co.

GAGES, Contour see **Gages, Profile**

GAGES, Cylinder
Ames Co., B. C.
Coats Mach. Tool
Comtor Co.
Federal Prod. Corp.
Lufkin Rule Co.
Pratt & Whitney
Starrett Co.
United Cinephone
Victor Equipment

GAGES, Depth, Linear
Ames Co., B. C.
Brown & Sharpe
Glogau & Co.
Instrument Specialties
Lincoln Park Tool & Gage
Lufkin Rule Co.
Park Sales
Pratt & Whitney
R & M Mfg. Co.
Starrett Co.
Union Tool Co.

GAGES, Depth, Navigational
Geophysical Inst. Co.

GAGES, Dial, Machinists'
Ames Co., B. C.
Brown & Sharpe
Chicago Dial Ind.
Federal Prod. Corp.
Ferner Co.
Genales, Andrew
General Engg & Model
Randall, Frank E.
Starrett Co.
Waltham Dial Gage

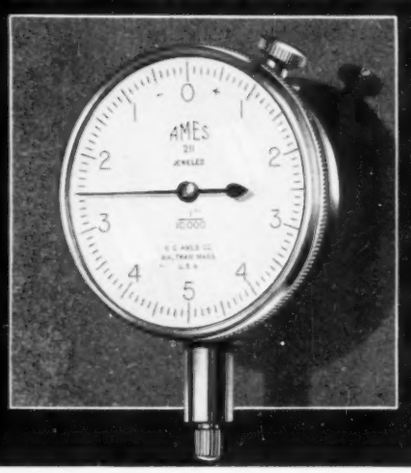
GAGES, Differential Pressure
American Meter Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Boiler Room Equip.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Crosby Steam Gage
Defender Automatic Reg.
Detroit Air Meter Co.
Dwyer Mfg. Co.
Ellison Draft Gage Co.
Foxboro Co.
Friez & Sons
Fuess, Inc.
Gas Appliance Specialties
Hays Corp.
Kollsman Instrument
Lambert Meter Co.
Leupold, Volpel & Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
Meriam Co.
Moeller Instrument
Moore Products Co.
Morey & Jones, Ltd.
Pioneer Instrument
Pitometer Log Corp.
Precision Therm.
Preferred Utilities Mfg.
Republic Flow Meters
Scientific Glass Apparatus
Scientific Inst. Co.
Simplex Valve & Meter
Tagliabue Mfg. Co.
Taylor Inst. Co.
Trimount Instrument
Uehling Instrument Co.
U. S. Gauge Co.

GAGES, Draft (See **Gages, Differential Pressure**)

GAGES, Drill Grinding
Lufkin Rule Co.
Morse Twist Drill
Starrett Co.

GAGES, Feeler
Improved Gauge Mfg.
Lufkin Rule Co.
Millers Falls Co.
Starrett Co.
Union Tool Co.
Van Keuren Co.

AMEs *Hundred Series* DIAL INDICATORS



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FEDERAL

DIAL INDICATORS
for
TESTING INSTRUMENTS

Federal Low Friction Federal Indicators lend themselves particularly to laboratory and scientific uses, where precision measurements must be exceptionally accurate. They are available in five sizes graduated from .00025" to 0.005".

For catalog including latest developments write to—

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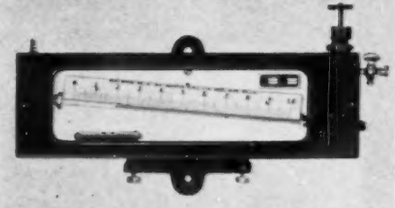
1142 Eddy St., Providence, R. I.
Detroit—Chicago—Cleveland—New York

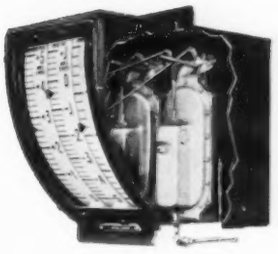
DRAFT GAUGES



● These are extremely serviceable direct reading instruments for measuring low pressures, drafts and differentials—built with inclined tubes to give increased scale length and permit the taking of readings in fractional inches of water. Each instrument individually calibrated to assure extremely accurate operation. Oil or mercury filled tubes. Also two-tube and three-tube models for taking multiple readings with the same gauge. Fully descriptive catalog sent on request.

THE MERIAM CO.
CLEVELAND, OHIO

Manometers, Meters, and Gauges for the accurate measurement of Pressures, Vacuums and Flows of Liquids and Gases.



BAILEY MULTI-POINTER GAGES

● Bailey Multi-Pointer Gages are made with any number of pointers and any scale combination from one to twelve. The pointers have 10° motion over plainly marked plastic molded scales so that readings can be taken at a distance of 20 feet. Diaphragm actuated elements enable this gage to withstand over-drafts and over-pressures without injury to the unit or its calibration.

All secondary factors such as draft, pressure, temperature, stoker speed and pulverizer feed can be indicated on one Bailey Multi-Pointer Gage.

BAILEY METER COMPANY
1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

For addresses, see pages 82-91

CERTIFIED

GAUGE & INSTRUMENT Corp.

PRESSURE AND VACUUM GAUGES

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The Instrument Laboratory, Inc., 126 Elliott Avenue, W., Seattle, Wash.

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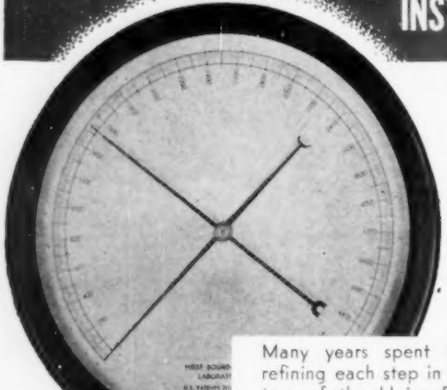
CERTIFIED GAUGE & INSTRUMENT CORP.
34-18 NORTHERN BOULEVARD, LONG ISLAND CITY, N. Y.

DEAD WEIGHT TEST . . . INSTANTLY



THE STANDARD OF THE WORLD

Many years spent in constantly refining each step in the manufacture of the Heise Bourdon tube makes possible the extreme accuracy guaranteed for each gauge which is to within ½ of 1% of the load **at any point of the scale** above 20% of the reading scale. The usual guarantee, for an accuracy to within ½ of 1% **of the maximum load of the scale**, permits an error at the lower scale readings up to 5 times greater than does the closer Heise guarantee.

HEISE BOURDON TUBE LABORATORIES
275 NOBLE AVENUE — BRIDGEPORT, CONNECTICUT
IN COLLABORATION WITH THE A. H. EMERY COMPANY

GAGES, Gas
Abercrombie Pump Co.
American Meter Co.
Bailey Meter Co.
Bastian-Blessing
Bristol Co.
Connelly Iron Sponge
Detroit Air Meter
Dickson Co.
Foxboro Co.
Gas Appliance Specialties
Lambert Meter Co.
Mason-Neilan Regulator
Rochester Mfg. Co.
Specialty Glass Co.
Superior Meter Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Victor Equipment

GAGES, Grinding
Ames Co., B. C.
Brown & Sharpe
Comtor Co.
Federal Prod. Corp.
Lufkin Rule Co.

GAGES, Height
Brown & Sharpe
Ford Motor Co.
General Engg. & Model
Lufkin Rule Co.
Scherr Co.
Starrett Co.

GAGES, Hook
Gurley, W. & L. E.
Leupold, Volpel & Co.
Scientific Inst. (Calif.)
White Co. Inc.

GAGES, Hydrostatic (See Gages, Liquid Level, Indicating)

GAGES, Internal Dial
Coats Mach. Tool
Comtor Co.
Federal Prod. Corp.
Gen. Engg. & Model Wks.
Scherr Co.

GAGES, Limit
Ford Motor Co.
General Elec. Co.
Gen. Engg. & Model Wks.
Greenfield Tap & Die
M-G Gage Corp.
Pratt & Whitney
Sheffield Gage
United Cinephone
Van Keuren Co.

GAGES, Liquid Level, Indicating
American Meter Co.
Ashton Valve Co.
Autocall Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Bastian-Blessing
Belfield Co.
Bin-Dicator Co.
Boston Auto Gage
Bowser & Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Burt Scientific Labs.
Certified Gauge
Clapp Instrument
Cochrane Corp.
Crosby Steam Gage
Davis Reg. Co.
Defender Automatic Reg.
Dickson Co.
Electric Auto-Lite
Elec. Indicator Corp.
Elec. Tachometer Corp.
Fisher Governor Co.
Foxboro Co.
Frick Co.
General Controls Co.
General Elec. Co.
Gurley, W. & L. E.
Hanlon-Waters, Inc.
International Filter Co.
Jerguson Gage Co.
Kellogg Switchboard
King Engineering
Klingerit, Inc.
Leeds & Northrup Co.
Leupold, Volpel
Liquidometer Co.
Lumenite Elec. Co.
Manning, Maxwell & Moore
Marsh Corp.
Mason-Neilan Regulator
McAlear Mfg. Co.
McNeill Engr. Equip.
Meriam Co.
Morey & Jones, Ltd.
Nathan Mfg. Co.
Natural Gas Equipment
Paragon Electric
Penberthy Injector Co.
Petrometer Corp.
Pioneer Instrument Co.
Pneumercator Co., Inc.
Precision Therm.
Preferred Utilities Mfg.
Reliance Gauge Column
Republic Flow Meters
Rochester Mfg. Co.
Schutte & Koerting Co.
Simplex Valve & Meter
Star Brass Mfg.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trimount Instrument
Uehling Instrument Co.
U. S. Gauge Co.
Vapor Recovery Systems
(Cont'd)

GAGES, Liquid Level, Indicating (Cont'd)
Wallace & Tiernan
Westinghouse Elec. & Mfg.
Wheelco Inst. Co.
Williams Gauge Co.
Wright-Austin Co.
Yarnell-Waring Co.

GAGES, Liquid Level, Recording (See Gages, Liquid Level, Indicating)

GAGES, Loss of Head
Bailey Meter Co.
Bristol Co.
Builders-Providence
Foxboro Co.
International Filter Co.
Morey & Jones, Ltd.
Taylor Inst. Cos.

GAGES, Mercury
Amthor Testing Mach.
Bacharach Industrial Inst.
Bailey Meter Co.
Builders-Providence
Central Scientific
Connelly Iron Sponge
Defender Automatic Reg.
Dubrovin, John
Dwyer Mfg. Co.
Eimer & Amend
Gas Appliance Specialties
Heise Bourdon Tube
Machlett & Son
Manning, Maxwell & Moore
Mason-Neilan Regulator
Meriam Co.
Moeller Instrument
Morey & Jones
Precision Therm.
Refinery Supply Co.
Scientific Glass Apparatus
Simplex Valve & Meter
Specialty Glass Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trerice Co.
Trimount Instrument
Uehling Instrument Co.

GAGES, Micrometer
Ames Co., B. C.
Amthor Testing Mach.
Brown & Sharpe
Central Scientific Co.
Coats Mach. Tool Co.
Gaertner Scientific Corp.
Haines Gauge Co.
Instrument Specialties Co.
Lufkin Rule Co.
Millers Falls Co.
Precision Therm. & Inst.
Scherr Co.
Van Keuren Co.
Zeiss, Inc., Carl

GAGES, Oil (See Gages, Liquid Level)

GAGES, Optical
Bausch & Lomb
Chicago Dial Ind. Co.
Clark & Sons
Fecker, J. W.
Gaertner Scientific Corp.
Jarrell-Ash Co.
Jones & Lamson Machine
Ruska & Co.
Scherr Co.
United Cinephone Corp.
Zeiss, Inc., Carl

GAGES, Paint Film
General Elec. Co.
Hathaway Inst. Co.
Instrument Specialties Co.
Munsell Color Co.
Saxl Inst. Co.

GAGES, Paper Thickness (See Gages, Thickness)

GAGES, Piston Ring
Littelfuse Inc.
Wilkening Mfg. Co.

GAGES, Pitch Diameter
Brown & Sharpe
Federal Prod. Corp.
Greenfield Tap & Die
Lufkin Rule Co.
Pratt & Whitney
Scherr Co., Inc.
Union Tool Co.
Van Keuren Co.
West & Dodge Thr. Gage

GAGES, Plug
Brown & Sharpe
Clark, Jr., Pneumatic
Ford Motor Co.
Greenfield Tap & Die
Lincoln Park Tool
Morse Twist Drill
Pratt & Whitney
Precision Gage & Tool
R & M Mfg. Co.
Sheffield Gage
Troy Tool & Gage
West & Dodge Thr. Gage

GAGES, Pneumatic Tank
Bacharach Industrial
Mason-Neilan Regulator
Pneumercator Co.
Rochester Mfg. Co.
Uehling Inst. Co.

GAGES, Precision Measuring
Ames Co., B. C.
Brown & Sharpe
Comtor Co.
Federal Prod. Corp.
Ferner Co.
Ford Motor Co.
Gaertner Scientific Corp.
Instrument Specialties Co.
Lufkin Rule Co.
Pratt & Whitney
Rieker Instrument Co.
Scherr Co., Inc.
Sheffield Gage
Starrett Co.
Thwing-Albert Inst. Co.
Van Keuren Co.
Carl Zeiss, Inc.

GAGES, Pressure, Indicating
Abercrombie Pump Co.
American Meter Co.
Ashton Valve Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Baird Associates
Baldwin-Southwark Corp.
Bastian-Blessing
Belfield Co.
Boekel & Co.
Bristol Co.
Brown Inst. Co.
Brush Development Co.
Builders-Providence
Central Scientific Co.
Certified Gauge
Clapp Instrument
Clark Blast Meter
Commercial Eng. Labs.
Consol. Ashcroft Hancock
Continental Elec. Co.
Crosby Steam Gage
Defender Automatic Reg.
Dickson Co.
Dubrovin, John
Edison Electrical Controls
Eimer & Amend
Electric Auto-Lite
Esterline-Angus Co.
Fisher Scientific Co.
Foxboro Co.
Fredericks, George
Friez & Sons
Gas Appliance Specialties
General Elec. Co.
Gotham Inst.
Green, Henry J.
Hays Corp.
Heise Bourdon Tube
Kurman Electric
Logansport Machine
Marsh Corp.
Mason-Neilan Regulator
Mercoid Corp.
Meriam Co.
Moeller Instrument Co.
Parks Co., Harry S.
Pioneer Instrument
Pittsburgh Equitable Met.
Plumb Co., Inc.
Precision Gage & Tool
Precision Therm.
Preferred Utilities Mfg.
RCA Manufacturing Co.
Refinery Supply Co.
Republic Flow Meters
Rochester Mfg. Co.
Scientific Inst. Co.
Star Brass Mfg. Co.
Stokes Machine Co.
Superior Meter Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trerice Co.
Trimount Instrument
Uehling Instrument Co.
United Cinephone Corp.
U. S. Gauge Co.
Victor Equipment Co.
Wagner & Son, Carl H.
Welch Mfg. Co.
Wilcus Manufacturing

GAGES, Pressure—Recording (See Gages, Pressure, Indicating)

GAGES, Pressure Temperature (See Gages, Pressure Indicating)

GAGES, Pressure, Tire
Air Balance Inst. Co.
U. S. Gauge Co.

GAGES, Pressure & Vacuum (See Gages, Pressure Indicating)

GAGES, Profile
Lincoln Park Tool
Pratt & Whitney
Precision Gage & Tool
R & M Mfg. Co.
Sheffield Gage
Stockton Profile Gauge
United Cinephone Corp.

GAGES, Radius
Lufkin Rule Co.
Starrett Co.
United Cinephone Corp.

GAGES, Rain (See Rain Gages)

GAGES, Rifle Bore
Hathaway Inst. Co.
Pratt & Whitney

For addresses, see pages 82-91

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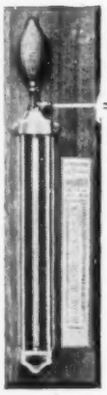

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PETROMETER will indicate all kinds of liquids lighter or heavier than water, stored in any type of tank or container made of steel, glass, hard rubber, concrete or other kinds of materials.

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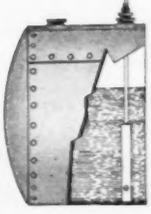

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GAGES, Ring
Brown & Sharpe
Greenfield Tap & Die
Lincoln Park Tool
Morse Twist Drill
Pratt & Whitney
Precision Gage & Tool
R & M Mfg. Co.
Sheffield Gage
Troy Tool & Gage
West & Dodge Thread
Zeiss, Inc., Carl

GAGES, Screw Thread
Brown & Sharpe
Clark, Jr. Pneumatic Tool
Federal Prod. Corp.
Greenfield Tap & Die
Lincoln Park Tool
Lufkin Rule Co.
Millers Falls Co.
Pratt & Whitney
Reed Small Tool Works
Sheffield Gage
Starrett Co.
Union Tool Co.
West & Dodge Thread
Zeiss, Inc., Carl

GAGES, Sliding
Pratt & Whitney
Van Keuren Co.

GAGES, Snap
Brown & Sharpe
Clark, Jr. Pneumatic Tool
Gen. Engg. & Model Wks.
Greenfield Tap & Die
Lincoln Park Tool
M-G Gage Corp.
Pratt & Whitney
Precision Gage & Tool
R & M Mfg. Co.
Scherr Co.
Sheffield Gage
Troy Tool & Gage

GAGES, Spline
Brown & Sharpe
Pratt & Whitney
Precision Gage & Tool
Sheffield Gage

GAGES, Star
Pratt & Whitney

GAGES, Strain
American Inst. Co.
Baldwin-Southwark
General Elec. Co.
Hathaway Inst. Co.
Metzger & Son
Miller Corp., Wm.
Olsen Testing Machine
Pratt & Whitney
Saxl Inst. Co.
Starrett Co.
Waugh Laboratories

GAGES, Surface
Ames Co., B. C.
Brown & Sharpe
Genales, Andrew
Federal Prod. Corp.
Lufkin Rule Co.
Millers Falls Co.
Saxl Inst. Co.
Starrett Co.
Zeiss, Inc., Carl

GAGES, Taper
Brown & Sharpe
Federal Prod. Corp.
Lincoln Park Tool
Precision Gage & Tool
Pratt & Whitney
R & M Mfg. Co.
Sheffield Gage
Starrett Co.

GAGES, Telescoping
Brown & Sharpe
Lufkin Rule Co.
Pacific Tool & Supply
Starrett Co.

GAGES, Thickness
American Askania Corp.
Ames Co., B. C.
Amthor Testing Inst. Co.
Brown & Sharpe
Federal Prod. Corp.
Ford Motor Co.
General Elec. Co.
Gen. Engg. & Model Wks.
Hathaway Inst. Co.
Ill. Testing Labs.
Instrument Specialties Co.
Lufkin Rule Co.
Magnetic Gauge Co.
Metzger & Son
Millers Falls Co.
Pratt & Whitney
Precision Gage & Tool
Precision Therm. & Inst.
Randall, Frank E.
R & M Mfg. Co.
Saxl Inst. Co.
Sheffield Gage
Speidel & Co.
Starrett Co.
Suter, Alfred
Twing-Albert Inst. Co.
Union Tool Co.
Van Keuren Co.
Waltham Dial Gage

GAGES, Thickness, Magnetic
American Inst. Co.
Commercial Eng. Labs.
General Elec. Co.
Hathaway Inst. Co.
Hickok Elec. Inst. Co.
Magnetic Gauge Co.

Stokes Portable Vacuum Gauges

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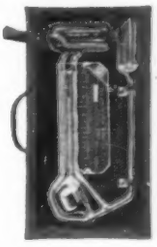

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Ballauf Mfg. Co.
Uehling Instrument Co.

GAGES, Torque
Martin Decker Corp.
Riehle Div.
Saxl Inst. Co.
Toledo Scale Co.

GAGES, Vacuum (See Gages, Pressure)

GAGES, Venturi (See Flow Meters, Venturi)

GAGES, Water Level (See Gages, Liquid Level)

GAGES, Wind
American Inst. Co.
Detroit Air Meter
Friez & Sons
Fuess, Inc.
Green, Henry J.
Kenyon Instrument Co
Rieker Inst. Co.
Taylor Inst. Cos.

GAGES, Wire Measuring
Ames Co., B. C.
Brown & Sharpe
Federal Prod. Corp.
Greenfield Tap & Die
Hathaway Inst. Co.
Instrument Specialties Co.
Pratt & Whitney
Starrett Co.

GALVANOMETERS, A-c.
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Cambridge Inst. Co.
Central Scientific Co.
General Elec. Co.
Hathaway Inst. Co.
Heiland Research Corp.
Leeds & Northrup Co.
Metals Research App.
Pfaltz & Bauer, Inc.
Rawson Electrical Inst.
RCA Manufacturing
Rubicon Co.
Sensitive Research Inst.
Tagliabue Mfg. Co.
Weich Mfg. Co.
Weston Elec. Inst.
Wheelco Inst. Co.

GALVANOMETERS, Astatic
Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
Hathaway Inst. Co.
Leeds & Northrup Co.
Metals Research App.
Rawson Electrical Inst.
Sensitive Research Inst.
Westinghouse Elec. & Mfg.
Wheelco Inst. Co.

GALVANOMETERS, D-c.
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Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
General Elec. Co.
G-M Labs.
Hathaway Inst. Co.
Heiland Research
Hickok Elect. Inst. Co.
J-B-T Instruments
Leeds & Northrup Co.
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Pfaltz & Bauer, Inc.
Rawson Electrical Inst.
RCA Manufacturing Co.
Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Simpson Elec. Co.
Tagliabue Mfg. Co.
Thwing-Albert Inst.
Triplett Electrical Inst.
Welch Mfg. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
Wheelco Inst. Co.

GALVANOMETERS, Piezoelectric
Brush Development Co.

GALVANOMETERS, Reflecting
Heiland Research
Rawson Electrical Inst.
Rubicon Co.
Ruska & Co.

GALVANOMETERS, Vacuum-tube
Engineering Labs., Inc.
Hathaway Instrument Co.
Heiland Research
Measurements Corp.
Metals Research App.
(Cont'd)

GALVANOMETERS, Vacuum-tube (Cont'd)
National Technical Labs.
RCA Manufacturing
Tagliabue Mfg. Co., C. J.

GALVANOSCOPES
Central Scientific Co.

GAS ANALYZERS, Air
Burrell Technical Supply
Cambridge Inst. Co.
Central Scientific Co.
Eimer & Amend
Fish-Schurman Co.
Fisher Scientific Co.
Friez & Sons
Hebler Co.
Mercoid Corp.
Mine Safety Appliances
Permutit Co.
Sargent & Co.
Scientific Glass App.
Tagliabue Mfg. Co.
Willson Products, Inc.

GAS ANALYZERS, Ammonia
Burrell Technical Supply
Cambridge Inst. Co.
Engelhard, Chas.
Mercoid Corp.
Permutit Co.
Sargent & Co.
Tagliabue Mfg. Co.

GAS ANALYZERS, Carbon Dioxide
Ace Glass Inc.
Bacharach Industrial Inst.
Brown Inst. Co.
Burrell Tech. Supply
Cambridge Inst. Co.
Central Scientific Co.
Defender Automatic Reg.
Dwyer Mfg. Co.
Eimer & Amend
Ellison Draft Gage Co.
Engelhard, Chas.
Fish-Schurman Co.
Fisher Scientific Co.
Friez & Sons
Gow-Mac Instrument
Hays Corp.
Hebler Co.
Lantz-Phelps Corp.
Leeds & Northrup Co.
Machlett & Son
Permutit Co.
Potter Co.
Precision Therm.
Preferred Utilities Mfg.
Republic Flow Meters
Sargent & Co.
Scientific Glass App.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Uehling Instrument Co.
Williams Apparatus Co.

GAS ANALYZERS, Carbon Monoxide
Bacharach Industrial Inst.
Burrell Technical Supply
Cambridge Inst. Co.
Chicago Apparatus Co.
Eclipse Aviation
Eimer & Amend
Fish-Schurman Co.
Hays Corp.
Leeds & Northrup Co.
Machlett & Son
Mine Safety Appliances
Sargent & Co.
Scientific Glass App.
Scientific Inst. Co.
Tagliabue Mfg. Co.

GAS ANALYZERS, Chlorinated Hydrocarbons
Willson Products, Inc.

GAS ANALYZERS, Flue Gas (See Gas Analyzers, Carbon Dioxide)

GAS ANALYZERS, Hydrogen
Bacharach Industrial Inst.
Burrell Technical Supply
Chicago Apparatus Co.

GAS ANALYZERS, Hydrogen Sulphide
American Meter
Burrell Technical Supply
Bushnell & Nevins
Cambridge Inst. Co.
Connelly Iron Sponge
Davis Emergency Equip.
Eimer & Amend
Johnson-Williams, Ltd.
Mine Safety Appliances
Rubicon Co.
Sargent & Co.
Scientific Glass Apparatus

GAS ANALYZERS, Nitric Oxide
Cambridge Inst. Co.
Eimer & Amend
Rubicon Co.
Sargent & Co.

GAS ANALYZERS, Orsat
Ace Glass Inc.
Bailey Meter Co.
Burrell Technical Supply
Central Scientific Co.
Chicago Apparatus Co.
Defender Automatic Reg.
Dwyer Mfg. Co.
Eimer & Amend
Ellison Draft Gage
Fish-Schurman Co.
Fisher Scientific Co.
Hays Corp.
Machlett & Son
Precision Therm.
Sargent & Co.
Scientific Glass App.
Specialty Glass Co.

GAS ANALYZERS, Oxygen
Burrell Technical Supply
Chicago Apparatus Co.
Cambridge Inst. Co.
Eclipse Aviation
Eimer & Amend
Hays Corp.
Hebler Co.
Mine Safety Appliances
Sargent & Co.
Scientific Glass App.
Tagliabue Mfg. Co.

GAS ANALYZERS, Oxygen & Nitrogen Apparatus
Boekel & Co.
Burrell Technical Supply
Cambridge Inst. Co.
Central Scientific Co.
Eimer & Amend
Hebler Co.
Sargent & Co.
Tagliabue Mfg. Co.

GAS ANALYZERS, Sulphur Dioxide
Bacharach Industrial Inst.
Bushnell & Nevins
Cambridge Inst. Co.
Eimer & Amend
Engelhard, Chas.
Fish-Schurman Co.
Hebler Co.
Leeds & Northrup Co.
Sargent & Co.
Scientific Glass App.
Tagliabue Mfg. Co.
Uehling Instrument Co.

GAS APPARATUS, Orifice Well Tester
Refinery Supply Co.

GAS DENSITY METERS
American Meter Co.
Central Scientific Co.
Ess Inst. Co.
Precision Therm.
Refinery Supply Co.
Permutit Co.

GAS FLOW INDICATORS
American Meter Co.
Askania Regulator Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Cochrane Corp.
Fischer & Porter
Fish-Schurman Co.
Foxboro Co.
Mason-Neilan Regulator
Meriam Co.
Pittsburgh Equitable Met.
Precision Scientific Co.
Republic Flow Meters
Selas Company
Simplex Valve & Meter
Tagliabue Mfg. Co.
Taylor Inst. Co.

GAS HOLDER POSITION INDICATORS
Bailey Meter Co.
Elec. Indicator Corp.
Elec. Tachometer Corp.
Foxboro Co.
Zuhr, Inc., Henry

GAS LEAK INDICATORS
Bullard Co.
Davis Emergency Equip.
Gilmore, E. R.
Heiland Research Corp.
Johnson-Williams, Ltd.
McFarlin Co.
Taylor Inst. Cos.
Water Leak Detector Co.
Western Instrument Co.

GAS METERS, INFERENTIAL — Area (See Flowmeters, Area)

GAS METERS, INFERENTIAL—Flow Nozzle (See Flowmeters, Orifice and Nozzle)

GAS METERS, INFERENTIAL—Orifice (See Flowmeters, Orifice and Nozzle)

GAS METERS, INFERENTIAL — Pitot-tube (See Flowmeters, Pitot-tube)

GAS METERS, INFERENTIAL—Venturi (See Flowmeters, Venturi)

GAS METERS, POSITIVE, Bellows, Slide-valve
American Meter Co.
Cleveland Gas Meter
Lambert Meter Co.
Littelfuse Inc.
Pittsburgh Equit. Meter
Sprague Meter Co.
Superior Meter Co.

GAS METERS, POSITIVE, Rotary
Pittsburgh Equit. Meter

GAS METERS, POSITIVE, Special for extremely small flows
American Meter Co.
Detroit Air Meter Co.

GAS METERS, POSITIVE, Wet-drum
American Meter Co.
Lambert Meter Co.
Precision Scientific Co.
Superior Meter Co.

GAS & VAPOR DISCHARGE TUBES, Argon
DuMont Labs., Inc., A.B.

GAS & VAPOR DISCHARGE TUBES, Carbon Dioxide
Barkon-Frink
Central Scientific Co.
Fredericks, George
Friez & Sons

GAS & VAPOR DISCHARGE TUBES, Hyrogen
Baird Associates
General Physical Lab.

GAS & VAPOR DISCHARGE TUBES, Mercury
Barkon-Frink
Central Scientific Co.
Fredericks, George
Gen. Elec. Lamp Dept.
General Physical Lab.
Jarrell-Ash Co.
Machlett & Son

GAS & VAPOR DISCHARGE TUBES, Neon
Barkon-Frink
Central Scientific Co.
Fredericks, George
Gen. Elec. Lamp Dept.
(Cont'd)

GAS & VAPOR DISCHARGE TUBES, Neon (Cont'd)
General Physical Lab.
Jarrell-Ash Co.
Machlett & Son

GAS & VAPOR DISCHARGE TUBES, Nitrogen
Central Scientific Co.
Fredericks, George
General Physical Lab.

GAS & VAPOR DISCHARGE TUBES, Sodium
Central Scientific Co.
Fredericks, George
Gen. Elec. Lamp Dept.
Jarrell-Ash Co.

GASOLINE MILEAGE TESTER (For automobiles and trucks) (See Meters, Mileage)

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Fellows Gear Shaper

GENERATORS, SIGNAL
Andrew, Victor J.
Bendix Marine Products
Boonton Radio Corp.
Clough-Brengle Co.
Electronic Design Corp.
Ferris Inst. Corp.
General Radio Co.
Jackson Electrical Inst.
Measurements Corp.
Pioneer Instrument
Radio City Products Co.
RCA Manufacturing Co.
Televiso Co.
Triplett Electrical Inst.
United Transformer Corp.
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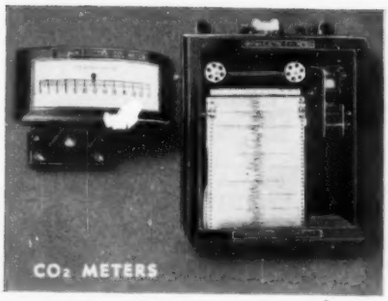

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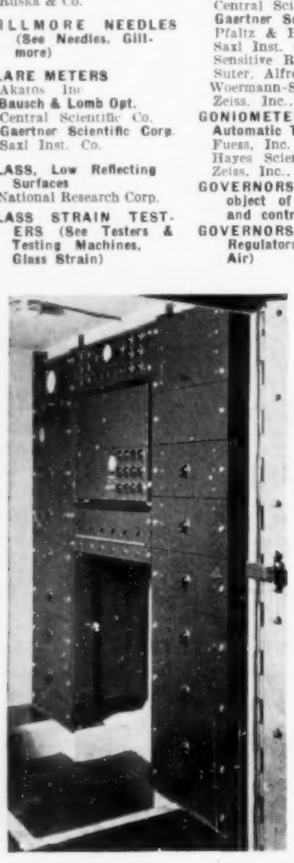

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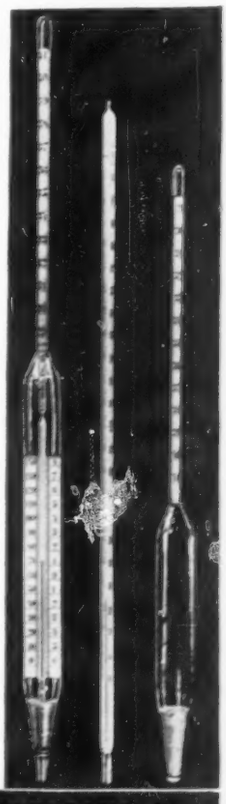

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Bausch & Lomb Opt.
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Gaertner Scientific Co.
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G-M Labs.
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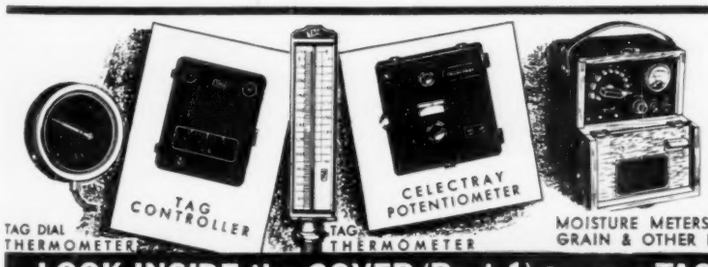

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Bowser & Co., Inc.
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Pgh. Equitable Meter
Smith Meter Co.
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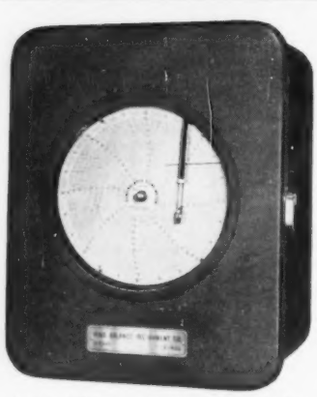

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Mason-Neilan Regulator
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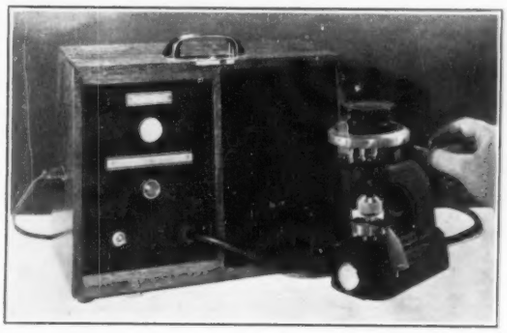

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Leitz, Inc.
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Detroit Testing Mach.
Fisher Scientific Co.
Fuess, Inc.
Gaertner Scientific Corp.
Leitz, Inc.
Pittsburgh Inst. & Mach.
Riehle Division
Suter, Alfred

MICROSCOPES, Dark Field
Bausch & Lomb Opt.
Spencer Lens Co.

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Gaertner Scientific Corp.
Leitz, Inc.
Scherr Co., Inc.
Spencer Lens Co.
Zeiss, Inc., Carl

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MICROSCOPES, Measuring
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Scherr Co., Inc.
Zeiss, Inc., Carl

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Fuess, Inc.
Leitz, Inc.
Spencer Lens Co.
Zeiss, Inc., Carl

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Fuess, Inc.
Gaertner Scientific Corp.
Goerz Amer. Optical
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MILLIVOLTMETERS (See Voltmeters, Millivoltmeters)

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Impact Register
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MOTORS, Laboratory
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General Elec. Co.
L. A. B. Corp.
Machlett & Son
Merkle-Korff Gear Co.
Parr Instrument Co.
Sargent & Co.
Welch Mfg. Co.

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Columbia Elec. Mfg.
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RCA Manufacturing
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NEEDLES, Gillmore
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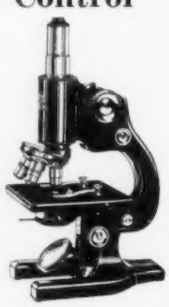

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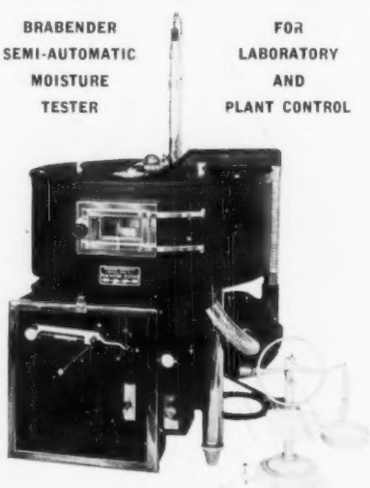

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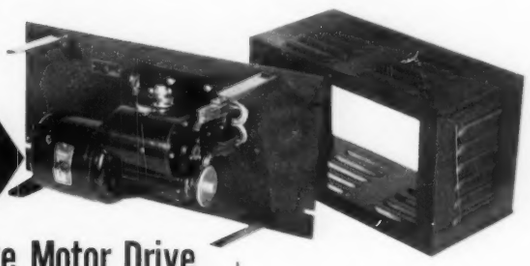

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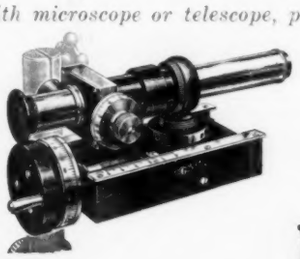

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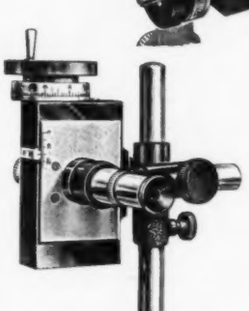

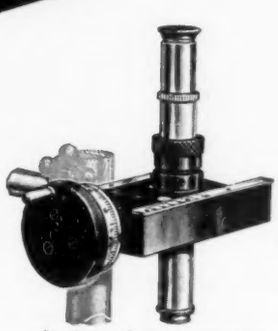

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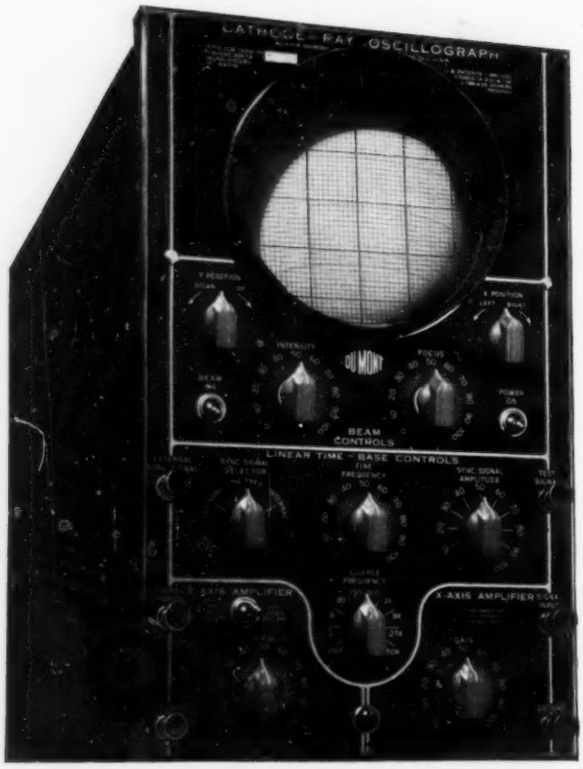

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Supreme Instruments
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Triplett Electrical Inst.
Triumph Mfg. Co.
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Weston Elec. Inst. Corp.

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Heiland Research
United Cinephone Corp.
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Clough-Brengle Co.
DuMont Labs., Inc., A.B.
Electro-Medical Lab.
Electronic Design Corp.
Fredericks, George
General Elec. Co.
General Radio Co.
Hickok Elec. Inst. Co.
Jackson Electrical Inst.
Raytheon Mfg. Co.
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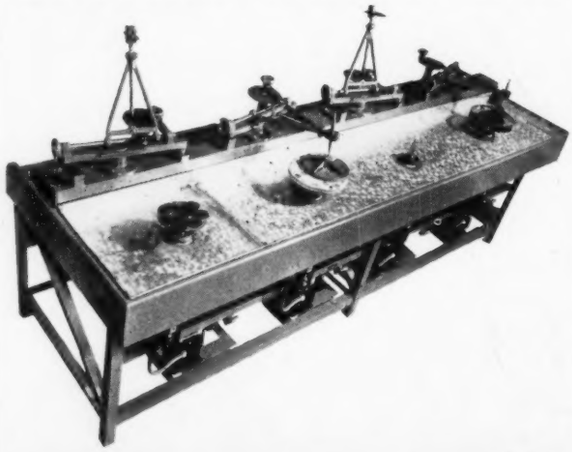

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Engineering Labs., Inc.
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Geophysical Instrument Co.
Hathaway Inst. Co.
Heiland Research Corp.
Ruska & Co., Inc.
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RCA Manufacturing Co.
Shallcross Mfg. Co.
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OVENS, Controlled atmosphere
Sodemann Heat & Power

OVENS, Crystal Oscillator
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RCA Manufacturing
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OVENS, Laboratory
Am. Gas Furnace
Boekel & Co.
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Braun Corp.
Burrell Tech. Supply
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Dietert Co.
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Falstrom Co.
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Clough-Brengle Co.
Daven Co.
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Ferris Inst. Corp.
Hickok Elec. Inst. Co.
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Triumph Mfg. Co.
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Speidel & Co.
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Warren-Knight Co.

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Kollmorgen Optical Co.
Lenox Inst. Co.
Perkin-Elmer Corp.

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Keuffel & Esser Co.
Kollmorgen Optical Co.

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Cambridge Inst. Co.
Fisher Scientific Co.
General Electric Co.
Hathaway Inst. Co.
Leeds & Northrup Co.
Rubicon Co.
Welch Mfg. Co.

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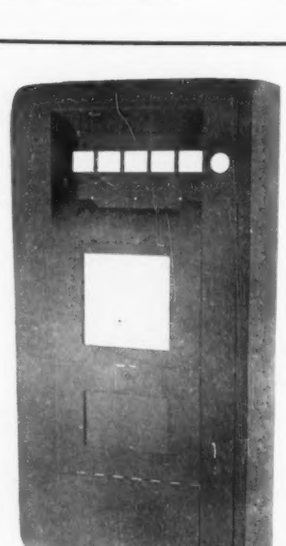

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Rhamstine, J. Thos.
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Gaertner Scientific Corp.

PHOTOMETERS, Candle
Connelly Iron Sponge

PHOTOMETERS, Flicker
Precision Therm.

PHOTOMETERS, Illumination
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G-M Labs.
Leitz, Inc.

PHOTOMETERS, Micro
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Baird Associates
Cambridge Inst. Co.
Gaertner Scientific Corp.
Hayes Scientific App.
Jarrell-Ash Co.
Mico Instrument Co.

PHOTOMETERS, Neutral Wedge
American Inst. Co.
Gaertner Scientific Corp.

PHOTOMETERS, Photoelectric
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Applied Research Labs.
Cambridge Inst. Co.
Central Scientific Co.
De Jur Amsco Corp.
Electronic Prods. Co.
Gaertner Scientific Corp.
General Elec. Co.
G-M Labs.
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Photovolt Corp.
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Zeiss, Inc., Carl

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American Inst. Co.
Bausch & Lomb Opt.
Gaertner Scientific Corp.
Munsell Color Co.

PHOTOMETERS, Spectro
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American Inst. Co.
Baird Associates
Bausch & Lomb Opt.
Coleman Electric Co.
Fuess, Inc.
Gaertner Scientific Corp.
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PITOT TUBES (see Flowmeters, Pitot Tube)

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Speidel & Co.
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Fecker, J. W.
Fuess, Inc.
Gaertner Scientific Corp.
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Foxboro Co.
RCA Manufacturing
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Foxboro Co.
Leeds & Northrup Co.
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Tagliabue Mfg. Co.
Weston Elec. Inst. Corp.

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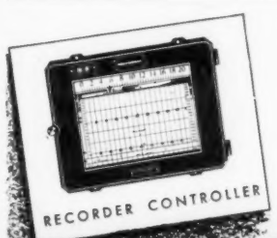

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Mason-Neilan Regulator
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Bristol Co.
Brown Inst. Co.
Builders-Providence
Clapp Instrument
Crosby Steam Gage Co.
Dickson Co.
Foxboro Co.
Heise Bourdon Tube Co
Hoke, Inc.
Kenyon Instrument Co.
Kollsman Inst. Co.
Marsh Corp., Jas. P.
Mason-Neilan Regulator
Pioneer Instrument
Republic Flow Meters
Star Brass Mfg. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trerice Co.

PRESSURE INDICATORS, Diaphragm, etc.
Abercrombie Pump Co.
Bailey Meter Co.
Brown Inst. Co.
(Cont'd)

PRESSURE INDICATORS, Diaphragm, etc.
(Cont'd)
Dickson Co.
Foxboro Co.
Kollsman Inst. Co.
Marsh Corp., Jas. P.
Mason-Neilan Regulator
Morey & Jones, Ltd.
Pioneer Instrument
Powers Regulator Co.
Rochester Mfg. Co.
Tagliabue Mfg. Co.
Taylor Instrument Cos.

PRESSURE INDICATORS, Electrical-resistance
Baldwin-Southwark Corp.
General Elec. Co.
Kurman Electric Co.
Rubicon Co.

PRESSURE INDICATORS, Inverted-bell
Bacharach Indus. Inst.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Dickson Co.
Foxboro Co.
Mason-Neilan Regulator
Taylor Inst. Cos.
Uehling Inst. Co.

PRESSURE INDICATORS, Membrane
Bailey Meter Co.
Dickson Co.
Mason-Neilan Regulator

PRESSURE INDICATORS, Piezoelectric
Batcher, Ralph R.
Brush Development Co.
Commercial Engg. Labs.
RCA Manufacturing Co.

PRESSURE INDICATORS, Piston, Weight-loaded
American Inst. Co.
Bailey Meter Co.
Hagan Corp.
Pioneer Instrument
Ruska & Co.

PRESSURE INDICATORS, Single-tube, liquid column
Bacharach Indus. Inst.
Detroit Air Meter Co.
Dwyer Mfg. Co.
Gas App. Specialties
Meriam Co.
Morey & Jones, Ltd.
Pioneer Instrument
Precision Therm.
Uehling Instrument Co.

PRESSURE INDICATORS, Spring-loaded piston
Bacharach Indus. Inst.
Commercial Engg. Labs.

PRESSURE INDICATORS, U-tube
Amthor Test. Mach.
Bacharach Indus. Inst.
Bailey Meter Co.
Connelly Iron Sponge
Detroit Air Meter Co.
Dwyer Mfg. Co.
Friez & Sons
Gas App. Specialties
Gotham Inst. Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
Meriam Co.
Moeller Instrument Co.
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Precision Therm.
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STOP WASTE OF ELECTRICAL POWER!

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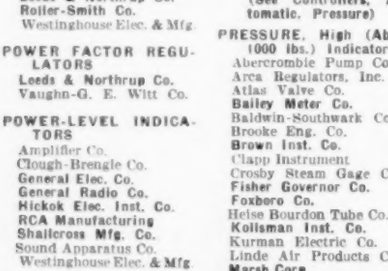

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WATTS (H.P.)
POWER FACTOR
Reactive Kilovolt-Amperes
Phase Rotation Indicator

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VOLTS
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WATTS
0—300 min. to 240,000

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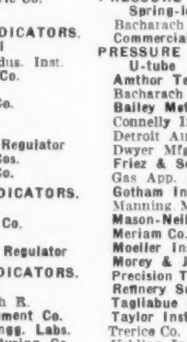

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Morey & Jones, Ltd.
Republic Flow Meters
Tagliabue Mfg. Co.
Taylor Inst. Cos.

PRESSURE RECORDERS, Bourdon tube
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Baldwin-Southwark Corp.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Dickson Co.
Esterline-Angus Co.
Foxboro Co.
Gotham Inst. Co.
Improved Gauge Mfg. Co.
Kenyon Instrument Co.
Leeds & Northrup Co.
Manning, Maxwell & Moore
Marsh Corp., Jas. P.
Mason-Neilan Regulator
Morey & Jones, Ltd.
Republic Flow Meters
Star Brass Mfg. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thrush & Co., H. A.
Trerice Co.

PRESSURE RECORDERS, Capsular spring
Tagliabue Mfg. Co.

PRESSURE RECORDERS, Diaphragm
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Brown Inst. Co.
Foxboro Co.
Dickson Co.
Marsh Corp., Jas. P.
Mason-Neilan Regulator
Morey & Jones, Ltd.
Tagliabue Mfg. Co.

PRESSURE RECORDERS, Electrical-resistance
Republic Flow Meters

PRESSURE RECORDERS, Inverted-bell
Bacharach Indus. Inst.
Bailey Meter Co.
Bristol Co.
Dickson Co.
Foxboro Co.
Leeds & Northrup Co.
Mason-Neilan Regulator
Taylor Inst. Cos.
Uehling Instrument Co.

PRESSURE RECORDERS, Membrane
Mason-Neilan Regulator

PRESSURE RECORDERS, Piezoelectric
Brush Development Co.
RCA Manufacturing Co.

PRESSURE RECORDERS, Piston, weight-loaded
Bailey Meter Co.

PRESSURE RECORDERS, Single-tube liquid column
Trerice Co.
Uehling Instrument Co.

PRESSURE RECORDERS, Spring-loaded piston
Bacharach Indus. Inst.
Baldwin-Southwark Corp.
Commercial Engg. Labs.
Esterline-Angus Co.

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Brown Inst. Co.
Foxboro Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
Republic Flow Meters
Tagliabue Mfg. Co.
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Rieker Inst. Co.
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RCA Manufacturing
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Burton Mfg. Co.
Leitz, Inc.
Spencer Lens Co.
Zeiss, Inc.

PROJECTORS, Rectifying
Abrams Instrument

PROTRACTORS, Bevel (See Drawing Instruments)

PROTRACTORS, Course
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Bliss & Co.
Eastern Science Co.
Kenyon Instrument Co.
Keuffel & Esser Co.
Marine Compass Co.
Negus, T. S. & J. D.
Warren-Knight Co.

PROTRACTORS, Navigators (See Protractors, Course)

PROTRACTORS, Transparent (See Drawing Instruments)

PROVERS, Gas Meter
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Pittsburgh Equit. Meter
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PROVERS, Water Meter
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Olsen Testing Machine
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Brush Development Co.
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Brown Inst. Co.
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H-B Inst. Co., Inc.
Mason-Neilan Regulator
Moeller Instrument Co.
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Parks-Cramer Co.

PSYCHROMETERS, Electric (See Psychrometers, Aspiration)

PSYCHROMETERS, Recording (See Hygrometers, Recording)

PSYCHROMETERS, Sling
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American Inst. Co.
American Moistening Co.
Central Scientific Co.
Chicago Apparatus Co.
Foxboro Co.
Fried & Lustig
Friez & Sons
Fuess, Inc.
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Rubicon Co.
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Roller-Smith Co.
Rubicon Co.
Tagliabue Mfg. Co.
Thwing-Albert Inst. Co.
Wheelco Inst. Co.

PYROMETERS, Expansion
Defender Automatic Reg.
Ferner Co.
Partlow Corp.
Tagliabue Mfg. Co.

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Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Burling Inst. Co.
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Elematic Sales Corp.
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Ill. Testing Labs.
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Pyrometer Inst. Co.
Roller-Smith Co.
Rubicon Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thwing-Albert Instrument
Wheelco Inst. Co.

PYROMETERS, Millivoltmetric
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Bristol Co.
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Cambridge Inst. Co.
Da Jur-Amsco Corp.
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Rubicon Co.
Taylor Inst. Cos.
Thwing-Albert Instrument
Wheelco Inst. Co.

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Brown Inst. Co.
Burrell Technical Supply
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Bristol Co.
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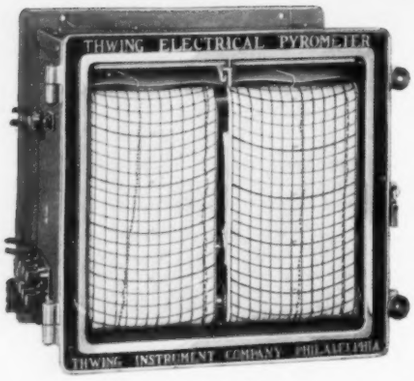
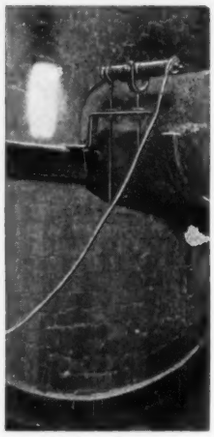
THWING-ALBERT Plant

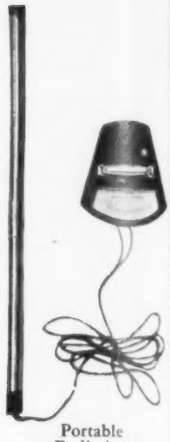


Multiple Recording Pyrometer

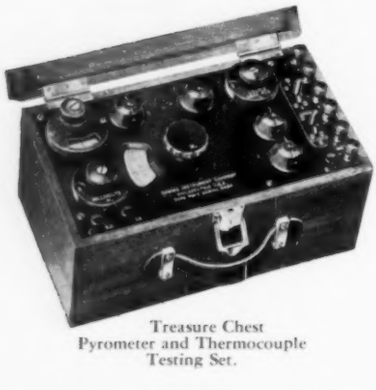
Indicating Pyrometer combined with Selector Switch



Radiation Pyrometer for Rotary Kiln



Portable Radiation Pyrometer



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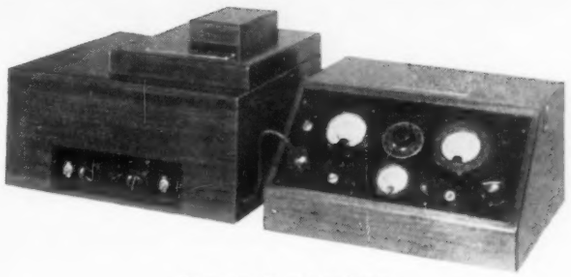
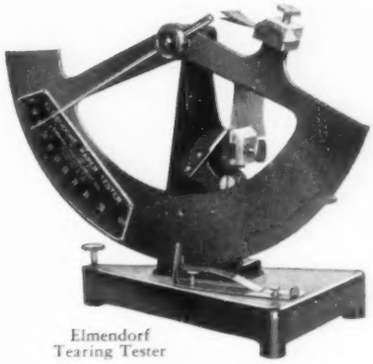
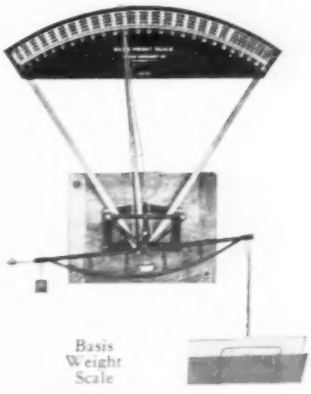


Formation Tester for Paper



Elmendorf Tearing Tester



Basis Weight Scale

indicating radiation pyrometers for highest temperatures encountered in industry, i.e., high temperature furnaces in glass plants, front end temperatures in rotary kilns, etc.; automatic temperature control equipments for oil and gas fired and electrically heated furnaces; portable potentiometers; pyrometer and thermocouple testing sets; recording and indicating electrical resistance thermometers for accurate measurement of very low temperatures.

Also, we manufacture a variety of instruments for the Aircraft Industry, including Tensiometers, Pelorus Drift Sights, Airplane Engine Cylinder Thermometer Testers, Aircraft Pyrometer Switches, Radio Selector Switches, Vibration Testers, Dial Gauge Calibrators, etc.

For the paper industry we manufacture an extensive line of testing instruments, all made to conform to the technical and physical requirements of the industry. These paper testing instruments have proved an important factor in promoting the technical advancement in the industry in recent years.

Illustrations on these pages show a few of the better-known Thwing-Albert Instruments.

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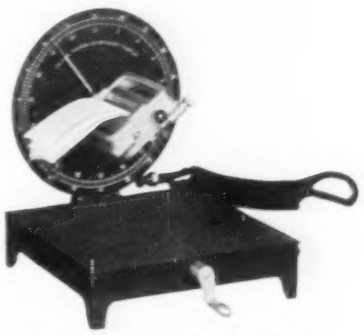

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Lewis Engg. Co.
Pyrometer Instrument Co.
Rubicon Co.
Tagliabue Mfg. Co.
Thwing-Albert Instrument
Wheelco Inst. Co.

PYROMETERS, Potentiometric
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Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
Dickson Co.
Foxboro Co.
J-B-T Insts., Inc.
Leeds & Northrup Co.
Lewis Engg. Co.
Rubicon Co.
Tagliabue Mfg. Co.
Thwing-Albert Instrument
Wheelco Inst. Co.

PYROMETERS, Radiation, Controlling
Am. Gas Furnace Co.
Bacharach Indust. Inst.
Bailey Meter Co.
Brown Inst. Co.
Cambridge Inst. Co.
Engelhard, Chas.
Foxboro Co.
General Elec. Co.
Ill. Testing Labs.
Leeds & Northrup Co.
Thwing-Albert Instrument
Wheelco Inst. Co.

PYROMETERS, Radiation, Indicating
Bachrach Industrial Inst.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
General Elec. Co.
Leeds & Northrup Co.
Pyrometer Instrument Co.
Thwing-Albert Instrument
Wheelco Inst. Co.

PYROMETERS, Radiation, Recording
Bachrach Industrial Inst.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
General Elec. Co.
Leeds & Northrup Co.
Pyrometer Instrument Co.
Thwing-Albert Instrument

PYROMETERS, Thermoelectric, Immersion
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
Elematic Sales Corp.
General Elec. Co.
Ill. Testing Labs.
J-B-T Insts., Inc.
Leeds & Northrup Co.
Lewis Engg. Co.
Partlow Corp.
Pyrometer Inst. Co.
Roller-Smith Co.
Tagliabue Mfg. Co.
Thwing-Albert Instrument
Woermann-Schuchhardt

PYROMETERS, Thermoelectric, Indicating
Am. Gas Furnace Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
De Jur-Amsco Corp.
Elematic Sales Corp.
Foxboro Co.
Hoskins Mfg. Co.
Ill. Testing Labs.
J-B-T Insts., Inc.
Leeds & Northrup Co.
Lewis Engg. Co.
Partlow Corp.
Pyrometer Instrument Co.
Roller-Smith Co.
Rubicon Co.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thwing-Albert Instrument
Western Instrument Co.
Wheelco Inst. Co.

PYROMETERS, Thermoelectric, Recording & Controlling
Bacharach Indust. Inst.
Bailey Meter Co.
Beck Co.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
Engelhard, Chas.
Foxboro Co.
General Elec. Co.
Ill. Testing Labs.
(Cont'd)

PYROMETERS, Thermoelectric, Recording & Controlling (Cont'd)
Leeds & Northrup
Lewis Engg. Co.
Mason-Neilan Regulator
Partlow Corp.
Pyrometer Instrument Co.
Tagliabue Mfg. Co.
Thwing-Albert Instrument

PYROMETERS, Thermoelectric, Surface Contact
Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
Elematic Sales Corp.
Foxboro Co.
General Elec. Co.
Ill. Testing Labs.
J-B-T Instruments
Lewis Engg. Co.
Pyrometer Instrument Co.
Schweitzer & Conrad
Tagliabue Mfg. Co.
Thwing-Albert Instrument

PYROMETRIC CONES (See Cones, Pyrometric)

QUARTZ, Fused Quartz Apparatus
Hanovia Chem. & Mfg.
Thermal Syndicate Ltd.

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Faistrom Co.

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Andrew, Victor J.
United Cinephone Corp.
Wallace & Tiernan

RADIO FREQUENCY METERS
Andrew, Victor J.
Clough-Brengle Co.
Ferris Inst. Corp.
General Elec. Co.
Hickok Elec. Inst. Co.
Lampkin Laboratories
Measurement Corp.
Millen Mfg. Co.
Rawson Electrical Inst.
RCA Manufacturing Co.
Roller-Smith Co.
Sensitive Research Inst.
Simpson Elec. Co.
Triplett Electrical Inst.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RADIO FREQUENCY OSCILLATORS (See Oscillators, Radio Frequency)

RADIO-MICROMETERS (See Micrometers, Radio)

RADIO REMOTE CONTROL SYSTEMS
American Automatic Elec.
McFarlin Co.
Pioneer Instrument
United Cinephone Corp.
Wallace & Tiernan

RADIO SET ANALYZERS (See Analyzers, Radio Set)

RADIO TEST PANELS (See Panels, Radio Test)

RADIO TUBE CHECKERS (See Checkers, Radio Tube)

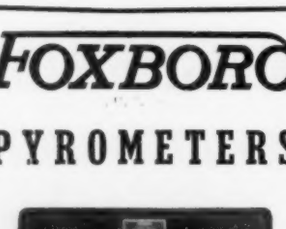
RAIN GAGES
Ballauf Mfg. Co.
Central Scientific Co.
Friez & Sons
Fuess, Inc.
Green, Henry J.
Gurley, W. & L. E.
Keuffel & Esser Co.
Leupold, Volpel & Co.
Precision Therm.
Taylor Inst. Cos.
Warren-Knight Co.
White Co., Inc.

RAINFALL RECORDERS
Esterline-Angus Co.
Friez & Sons
Fuess, Inc.
Green, Henry J.
Leupold, Volpel & Co.
Taylor Inst. Cos.

RANGE FINDING INSTRUMENTS
Fecker, J. W.
Gaertner Scientific Corp.
Kern Co.
Keuffel & Esser Co.
Kollmorgen Optical Co.
Leitz, Inc.
Precision Therm.
RCA Manufacturing
White Co., Inc.

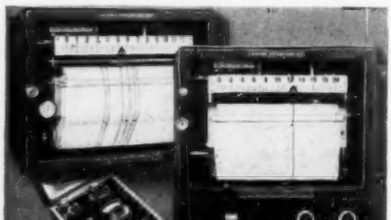
RANGE POLES (See Surveying Instruments)

FOXBORO
PYROMETERS



The Foxboro Pyrometer line embraces a variety of types including Indicators, Controllers and Recorder Controllers. Single and multiple recording instruments up to eight records on one chart are available. The Recorder-Controller is made in several types, both air- and electrically-operated, to fill practically every conceivable need.

For complete information write for Bulletin No. 190-4. **The Foxboro Company, 46 Neponset Avenue, Foxboro, Massachusetts, U. S. A.** Branch offices in principal cities of the United States and Canada.



For Controlling, Recording and Indicating Temperatures from —150°F. to +3200°F.

An extremely accurate and dependable instrument, designed and built for industrial service. Operating on the Potentiometer Principle, the instrument can be located practically any distance from the point of temperature measurement (thermocouple location) without affecting its accuracy or dependability.

Charts and scales for a wide variety of ranges are available, from a minimum temperature span of 300° to a maximum span of 3000°F. Corresponding Centigrade scales and charts are also available.

Pyrometer accessories, such as thermocouples and extension lead wire, furnished with instruments to meet the individual requirements of each job.

Write for Catalog 1104. THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4482 Wayne Avenue, Philadelphia, Pa.

BROWN PYROMETERS
AND
MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS
To Measure and Control is to Economize

Portable Pyrometer Potentiometers

Both standard and pocket size instruments are available. All are truly portable, being free from effects of vibration and ambient temperature. Only one balancing operation is necessary. They may be used in any position and are standard test equipment for engine test stands, aircraft, trucks, tanks, and all vehicles while in motion.

(Write for Bulletin)

THE LEWIS ENGINEERING CO.
NAUGATUCK, CONNECTICUT

For addresses, see pages 82-91

PYROMETERS AND ACCESSORIES

Pyrometers-Thermometers-Thermostats

WALL, PANEL AND PORTABLE TEMPERATURE INSTRUMENTS A SPECIALTY (All applications)

THERMOCOUPLE PROTECTING TUBES
HOT JUNCTION DISCS
ALL THERMOCOUPLE ACCESSORIES

(in most cases available from stock)

Write for Bulletins 401, 401-A and D-1.

ELEMATIC CORPORATION
12757 S. Western Ave. Blue Island, Ill.

"Alnor" ELECTRONIC TYPE PYROMETER CONTROLLER

No motors, no depressor bars—no contacts

The Alnor is a simplified controller which operates on an electronic principle similar to a radio.

The pointer of the pyrometer carries a vane. Two similar condenser vanes are attached to the arm of the adjustable target. When the pyrometer pointer reaches the target setting, the pointer vane passes between the condenser vanes and causes a change in the capacity of the circuit which in turn actuates the switch controlling the heating current or fuel valve. A red eye tells whether the heat is on or off.

With no motors, contacts, depressor bars, there is no time lag in response and the utmost in ruggedness and durability is provided. *Write for bulletin No. 3197-A*

Illinois Testing Laboratories Inc.
142 WEST HUBBARD ST., CHICAGO, ILL.

PYRO THE SIMPLIFIED OPTICAL PYROMETER

YOU cannot afford NOT to own one!

Because it eliminates guesswork, waste and spoilage; it pays for itself quickly. PYRO is a **SELF-CONTAINED, DIRECT - READING, STURDY** unit made to stand rough use but it is absolutely accurate and dependable.

Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects or the smallest streams; no correction charts, no accessories, no upkeep.

Stock Ranges: 1400° to 5500° F.

PYRO RADIATION PYROMETER

Ideal for furnace or kiln use. Gives actual heat of material aside from furnace or kiln temperature. Does not require skilled operator. Stock ranges 1000° to 3600° F.

Write for special catalog on PYRO Optical, Bi-Optical, Micro-Optical, Radiation, Immersion and Surface Pyrometers.

THE PYROMETER INSTRUMENT CO.
103-107 LAFAYETTE ST., NEW YORK, N. Y.

Temperature Measuring Instruments

Wheelco Precision Temperature Measuring Instruments include:

INDICATING PYROMETERS—PORTABLE PYROMETERS — PORTABLE POTENTIOMETERS — RECORDING OR INDICATING THERMOMETERS — RESISTANCE THERMOMETERS, ETC.

Write for complete data on these instruments, today.

Wheelco Instruments Co.
833 HARRISON STREET - - - CHICAGO, ILLINOIS

J-B-T INDICATING PYROMETERS

- RUGGED, ACCURATE
- MANY SIZES, RANGES, INCLUDING 3" PANEL
- THERMOELECTRIC, OR POTENTIOMETRIC; ALSO RESISTANCE TYPE

Model 70-PO potentiometer-pyrometer (portable model illustrated—also wall mounted) combines potentiometer accuracy with ease of reading deflection instrument. Eliminates balancing, is read faster. Write for literature, suggesting application.

J-B-T INSTRUMENTS, Inc.
441-M CHAPEL ST. NEW HAVEN, CONN.

For addresses, see pages 82-91

REACTANCE METERS
Andrew, Victor J.
General Radio Co.
Premier Crystal Labs.
RCA Manufacturing
Rubicon Co.

READING LENSES, Thermometer & Burette (See Lenses, Reading)

RECORDERS (See object of measurement and control)

RECTIFIERS, Dry Disc
Am. Automatic Electric
Benwood Linze Co.
Control Corp.
Elec. Facilities, Inc.
General Elec. Co.
Mallory & Co.
Mellaphone Corp.
Raytheon Mfg. Co.
Standard Elec. Time
United Transformer Corp.

RECTIFIERS, Power
Applied Research Labs.
Benwood Linze
Eclipse Aviation
Elec. Facilities, Inc.
Electro Products Labs.
General Elec. Co.
Mellaphone Corp.
Raytheon Mfg. Co.
RCA Manufacturing
United Transformer Corp.

RECTIFIERS, Thermionic
American Automatic Elec.
Amplifier Co.
(Cont'd)

RECTIFIERS, Thermionic (Cont'd)
Andrew, Victor J.
Benwood Linze
Continental Elec. Co.
DuMont Labs., Inc., A.B.
Electro Products Labs.
Electrons, Inc.
General Elec. Co.
Hy-Ef Elec. Products
Mellaphone Corp.
Raytheon Mfg. Co.
RCA Manufacturing Co.
United Cinephone Corp.
United Transformer Corp.

REDUCING MOTIONS, ENGINE INDICATOR
Bacharach Indust. Inst.
Crosby Steam Gage Co.
Robertson, 3rd, J. L.
Trill Indicator Co.

REFLECTIONMETERS
Akatos, Inc.
Pfaltz & Bauer, Inc.

REFLECTOMETERS
Akatos, Inc.
American Inst. Co.
Higgins, Charles F.
Leeds & Northrup Co.
Photovolt Corp.

REFLECTORS, Aspherical
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.

REFLECTORS, Concave
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.
Tinsley Labs.

REFLECTORS, First Surface
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.
Tinsley Labs.

REFLECTORS, Heat Resisting
Am. Telescope Labs.
Bausch & Lomb Optical
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.

REFLECTORS, Parabolic
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.
Tinsley Labs.
Weber Bros. Metal Works

REFLECTORS, Spherical
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.
Tinsley Labs.

REFLECTORS, Stellite
American Telescope Labs.
Bausch & Lomb Optical
Fecker, J. W.
Kollmorgen Optical Co.
Perkin-Elmer Corp.

REFRACTOMETERS
Akatos, Inc.
Bausch & Lomb Optical
Central Scientific Co.
Fuess, Inc.
Gaertner Scientific
Industro-Scientific Co.
Jarrell-Ash Co.
Spencer Lens Co.
Zeiss, Inc., Carl

REFRACTORY TUBES
Coors Porcelain Co.

REGULATORS, AUTOMATIC (See also Controls, Automatic; and object of measurement and control)

REGULATORS, AUTOMATIC, Air
Acme Regulator Co.
American Meter Co.
Arca Regulators, Inc.
Askania Regulator Co.
Bailey Meter Co.
Bastian-Blessing Co.
Belfield Co.
Boekel & Co.
Boylston Co.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Cash Co.
Connelly Iron Sponge
Cutler-Hammer, Inc.
Davis Reg. Co.
D'Este Co.
Detroit Lubricator
Fisher Governor Co.
Foster Engg. Co.
Foxboro Co.
Friez & Sons
Johnson Service Co.
Judson Governor Co.
Kiely & Mueller
Lammert & Mann Co.
Leslie Co.
Linde Air Products Co.
(Cont'd)

REGULATORS, AUTOMATIC, Air (Cont'd)
Manning, Maxwell & Moore
Mason Neilan Regulator
McAlear Mfg. Co.
McCorkle Co.
Mercon Regulator Co.
National Airoil Burner
Natural Gas Equipment
Northern Equip. Co.
Parks-Cramer Co.
Partlow Corp.
Payne Furnace & Supply
Penn Electric Switch Co.
Pgh. Equitable Meter
Powers Regulator Co.
Preferred Utilities Mfg.
Republic Flow Meters
Reynolds Gas Regulator
Robertshaw Thermostat
Ruggles-Klingemann
Schade Valve Mfg.
Sprague Meter Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
United Cinephone Corp.
Vaughn-G.E. Witt Co.
Victor Equipment Co.
Watts Regulator Co.
White-Rodgers Electric
Wilgus Mfg. Co.

REGULATORS, AUTOMATIC, Atmospheric
Foxboro Co.
Mason-Neilan Regulator
Parks-Cramer Co.
Powers Regulator Co.
Robertshaw Thermostat

REGULATORS, AUTOMATIC, Boiler
Askania Regulator Co.
Bailey Meter Co.
Brooke Eng. Co.
Brown Inst. Co.
Cash Co.
Connelly Iron Sponge
Fisher Governor Co.
Foster Engg. Co.
Foxboro Co.
General Regulator Corp.
Hagan Corp.
Hays Corp.
Hanlon-Waters, Inc.
Mason-Neilan Regulator
McAlear Mfg. Co.
McDonnell & Miller
Minneapolis-Honeywell
National Brass Co.
Natural Gas Equipment
Penn Electric Switch
Perfex Corp.
Republic Flow Meters
Robertshaw Thermostat
Ruggles-Klingemann
Tagliabue Mfg. Co.
Wilgus Mfg. Co.

REGULATORS, AUTOMATIC, Compressed Gas
American Meter Co.
Bailey Meter Co.
Brooke Eng. Co.
Brown Inst. Co.
Cash Co.
Electrimatic Corp.
Fisher Governor Co.
Frick Co.
Gaertner Scientific
Hanlon-Waters, Inc.
Hoke, Inc.
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator Co.
Natural Gas Equipment
Pgh. Equitable Meter
Republic Flow Meters
Reynolds Gas Regulator
Robertshaw Thermostat
Tagliabue Mfg. Co.
Victor Equipment Co.

REGULATORS, AUTOMATIC, Condensation (See Controllers, Automatic, Condensation)

REGULATORS, AUTOMATIC, Consistency (Paper & Pulp) (See Controllers, Automatic, Consistency)

REGULATORS, AUTOMATIC, Current
Amperite Corp.
Amplifier Co.
Beck Bros.
Betts & Betts
(Cont'd)

REGULATORS, AUTOMATIC, Current (Cont'd)
Burlington Inst. Corp.
Cutler-Hammer, Inc.
General Elec. Co.
Monitor Controller Co.
Robertshaw Thermostat
Roller-Smith Co.

REGULATORS, AUTOMATIC, Damper (See Controllers, Automatic, Damper)

REGULATORS, AUTOMATIC, District (See Governors, District)

REGULATORS, AUTOMATIC, Draft (See Controllers, Automatic, Draft)

REGULATORS, AUTOMATIC, Drying Chamber
Powers Regulator Co.
United Cinephone Corp.

REGULATORS, AUTOMATIC, Feed Water
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Belfield Co.
Brown Inst. Co.
Cochrane Corp.
Davis Reg. Co.
Defender Automatic Reg.
General Regulator Corp.
Hagan Corp.
Hanlon-Waters, Inc.
Mason-Neilan Regulator
McAlear Mfg. Co.
(Cont'd)

REGULATORS, AUTOMATIC, Feed Water (Cont'd)
McDonnell & Miller
Mercon Regulator Co.
Minneapolis-Honeywell
Natural Gas Equipment
Northern Equip. Co.
Ruggles-Klingemann
Stets Co.
Tagliabue Mfg. Co.
Vaughn-G. E. Witt Co.
Watts Regulator Co.
Wilgus Mfg. Co.
Williams Gauge Co.

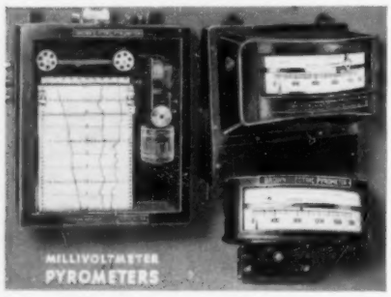
REGULATORS, AUTOMATIC, Flow (See Controllers, Automatic, Flow)

REGULATORS, AUTOMATIC, Flow Proportioning (See Controllers, Automatic, Flow Proportioning)

REGULATORS, AUTOMATIC, Fluid Proportioning (See Controllers, Automatic, Fluid Proportioning)

REGULATORS, AUTOMATIC, Frequency
Burlington Inst. Corp.
General Elec. Co.
Leeds & Northrup
Warren Telechron Co.
Wheelco Inst. Co.

REGULATORS, AUTOMATIC, Furnace (See Controllers, Automatic, Furnace)



For Controlling, Recording and Indicating Temperatures from 0 to 3000°F.

A direct-reading, simple and sturdy pyrometer, especially suited for industrial applications where simplicity and ruggedness are of greater importance than extreme accuracy. The instrument can be calibrated to compensate for long lengths of extension lead wire between thermocouples and instrument. No dry cells or standard cells required.

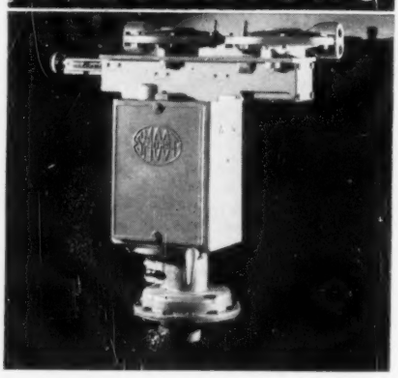
Charts and scales for a wide variety of ranges are available, from a minimum temperature span of 800°F. to a maximum span of 3000°F. Corresponding Centigrade scales and charts are also available.

Pyrometer accessories, such as thermocouples and extension lead wire, furnished with instruments to meet the requirements of each job.

Write for Catalog 15-F, THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4482 Wayne Avenue, Philadelphia, Pa.

BROWN PYROMETERS
AND
MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS
To Measure and Control is to Economize

REGULATORS



Republic-Smoot regulators are supplied for the automatic control of pressure, rate of flow, speed of rotation, level of a liquid or the proportioning of two pressures, flows, etc., in a fixed ratio by mechanically operating a valve, damper, rheostat or various types of variable speed transmissions.

Republic-Smoot regulators may be either oil or air operated. Their extreme flexibility in application and the degree to which they meet the four requirements of sensitivity, power, speed and stability, had been responsible to a large degree for the outstanding success of Republic-Smoot control systems.

WRITE FOR DATA BOOK No. S-13

REPUBLIC FLOW METERS CO.
2249 DIVERSEY PKWY., CHICAGO, ILLINOIS

TAG RECORDERS

These instruments are designed to record all temperatures from minus 200°C. up, and all industrial pressures. Ask for Catalogs—They graphically suggest the usefulness of TAG RECORDING THERMOMETERS and RECORDING PRESSURE GAGES for service and economy in your plant.

C. J. TAGLIABUE MFG. CO.
Park & Nostrand Avenues, Brooklyn, N. Y.

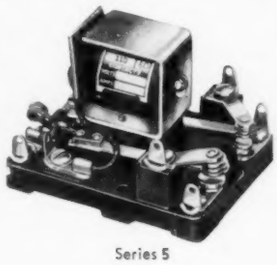
LOOK INSIDE the COVER (Part 1) *See How* TAG RECORDERS *Save You Money* TAG

For addresses, see pages 82-91

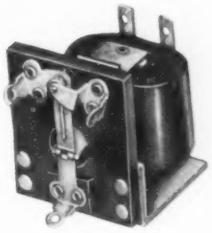
KURMAN ELECTRIC CO., Inc.

241-B LAFAYETTE STREET NEW YORK, NEW YORK

RELAYS TEST EQUIPMENT CONTROLS



Series 5



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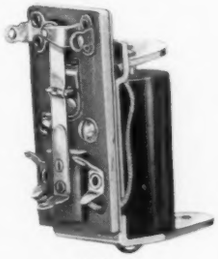

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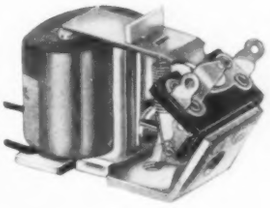


Series 12

GUIDE TO KURMAN RELAY SPECIFICATIONS

SERIES	RATED INPUT DC WATTS	RATED INPUT AC V.A.	AMPERE CONTACT RATING	WEIGHT OUNCES	DIMENSIONS INCHES
5	2.5	8.0	15	7 1/2	3x2 1/4 x2 1/8
10	.35	—	.5	1 1/2	1 7/8 x1x1 7/16
11	.80	4.4	1	2 1/8	1 3/4 x 1 1/2 x1 3/4
12	.018	—	.25	1 1/2	1 5/8 x1 1/8 x 1 1/2
15	2.0	6.0	1	3 5/8	1 3/4 x1 1/8 x1 3/4
25	2.0	4.0	10	4	2 1/16 x1 5/8 x1 1/16
200	.014	.36	3	6 5/8	2 5/8 x2 5/8 x1 5/8
300	.014	.36	3	6 5/8	2 5/8 x2 5/8 x1 5/8

NOTES

I. All current contact ratings are in amperes at 110 volts 60 cycle AC.

II. Dielectric strength of 1500 volts exists between contacts and ground in Series 10, 11, 15.

III. Insulated armature, shown on Series 300, is recommended for high frequency transfer. This feature may be specified for Series 200.

IV. Ferronickel alloy is used in the magnetic circuits for Series 10, 12, 200, 300.

V. Ceramic insulation in Series 25 permits high frequency transfer with low capacitive leakage.

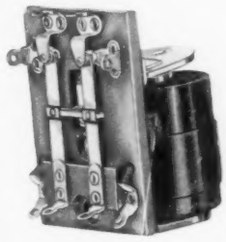
VI. Dampened armature action in Series 25 is designed to reduce contact bounce after initial pull down.

VII. Rated watts represents practical minimum input at standard adjustments.

VIII. AC relays have approximately .5 power factor.

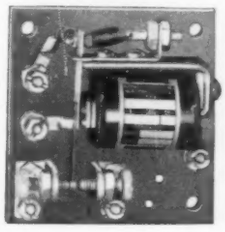
IX. List prices vary with specific voltage and insulation requirements.

RELAYS DESIGNED TO MEET YOUR SPECIFICATIONS

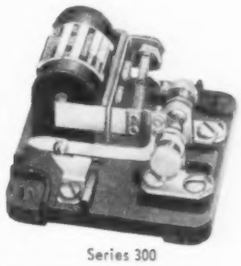


Series 15

Series 25



Series 200



Series 300

REGULATORS, AUTOMATIC, Gas (See Regulators, Automatic, Air)

REGULATORS, AUTOMATIC, Humidity (See Controllers, Automatic, Humidity)

REGULATORS, AUTOMATIC, Liquid Level (See Controllers, Automatic, Liquid Level)

REGULATORS, AUTOMATIC, Load
Allis-Chalmers Mfg. Co.
Autom'c Valve Controller
Hays Corp.
Leeds & Northrup Co.
Taylor Inst. Cos.

REGULATORS, AUTOMATIC, Oil Feed
Askania Regulator Co.
Atlas Valve Co.
Brown Inst. Co.
Cash Co.
D'Este Co.
Fisher Governor
Foster Engg. Co.
General Regulator Corp.
Hagan Corp.
Lammert & Mann Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
McCorkle Co.
National Airoil Burner
Republic Flow Meters
Spence Engineering Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
United Cinephone Corp.
Vaughn-G. E. Witt Co.
Wilgus Manufacturing

REGULATORS, AUTOMATIC, Power Factor
Allis-Chalmers Mfg. Co.
Leeds & Northrup Co.
United Cinephone Corp.

REGULATORS, AUTOMATIC, Pressure (See Controllers, Automatic, Pressure)

REGULATORS, AUTOMATIC, Pump
Allen-Bradley Co.
Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Belfield Co.
Boylston Co.
Brown Inst. Co.
(Cont'd)

REGULATORS, AUTOMATIC, Pump (Cont'd)
Builders-Providence
Cash Co.
Davis Reg. Co.
D'Este Co.
Fisher Governor Co.
Ford Reg. Valve Co.
Foster Engg. Co.
Furnas Electric Co.
General Regulator Corp.
Hagan Corp.
Hanlon-Waters, Inc.
Hydraulic Press Co.
Klipfel Mfg. Co.
Leslie Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator Co.
Northern Equip. Co.
Penn Electric Switch
Republic Flow Meters
Water Level Controls Co.
Schade Valve Mfg. Co.
Spence Engineering Co.
Tagliabue Mfg. Co.
Vaughn-G. E. Witt Co.
Watts Regulator Co.
Wilgus Mfg. Co.

REGULATORS, AUTOMATIC, Refrigeration (See Controllers, Automatic, Refrigeration)

REGULATORS, AUTOMATIC, RKVA
Allis-Chalmers Mfg. Co.

REGULATORS, AUTOMATIC, Safety Fuel Shut-Off (See Valves, Automatic, Safety Fuel

REGULATORS, AUTOMATIC, Steam Pressure (See Regulators, Automatic, Pressure)

REGULATORS, AUTOMATIC, Synchronizing
Allis-Chalmers Mfg. Co.
Industrial Engr. Corp.
Magnetic Gauge Co.

REGULATORS, AUTOMATIC, Temperature (See Controllers, Automatic, Temperature)

REGULATORS, AUTOMATIC, Time (See Controllers, Automatic, Time)

REGULATORS, AUTOMATIC, Vacuum (See Controllers, Automatic, Vacuum)

REGULATORS, AUTOMATIC, Viscosity (See Controllers, Automatic, Viscosity)

REGULATORS, AUTOMATIC, Voltage
American Transformer
Amperite Corp.
Amplifier Co.
Burlington Inst. Corp.
Clarostat Mfg. Co.
Eclipse Aviation
Electronic Prod. Co.
Ferris Inst. Corp.
Fredericks, George
General Elec. Co.
Ideal Commuto'r Dresser
International Resistance
Miller Co., Bertrand F.
Raytheon Mfg. Co.
Sola Electric Co.
United Cinephone Corp.
United Transformer Corp.
Ward Leonard Elec. Co.

REGULATORS, AUTOMATIC, Water Pressure (See Regulators, Automatic, Pressure)

REGULATORS, AUTOMATIC, Welding, Gas
Bastian-Blessing Co.
Victor Equipment Co.

REGULATORS, MANUAL (Non-Automatic)
Allen-Bradley Co.
Bailey Meter Co.
Beck Bros.
Belfield Co.
Brown Inst. Co.
Cutler-Hammer, Inc.
Fisher Governor
Hanlon-Waters, Inc.
McAlear Mfg. Co.
National Airoil Burner
National Elec. Controller
Pioneer Instrument
Superior Electric Co.
Tagliabue Mfg. Co.
United Transformer Corp.
Ward Leonard Elec. Co.

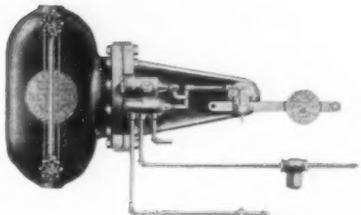
RELAYS, Automatic
Allen-Bradley Co.
American Inst. Co.
American Automatic Elec.
Autocall Co.
Clare & Co.
Cutler-Hammer, Inc.
Eclipse Aviation
General Controls Co.
General Elec. Co.
(Cont'd)

Kieley & Mueller PRODUCTS

63rd YEAR

A complete range of sizes and types in

Valves
Regulators
Liquid Level Controls
Strainers
Steam Traps
and
Engineering Specialties



Custom Sub-assemblies for all Valve Requirements

KIELEY & MUELLER, INC.

General Offices—40 West 13th St., N. Y. C.

Factory at Newark, N. J.

YOUR CONTROL ENGINEERS

For addresses, see pages 82-91

RELAYS, Automatic (Cont'd)
Guardian Elec. Mfg. Co.
Hagan Corp.
Industrial Eng. Corp.
Industrial Timer Corp.
Kellogg Switchboard
Mercoid Corp.
Minneapolis-Honeywell
Monitor Controller Co.
Paragon Electric Co.
Penn Electric Switch
Perfex Corp.
Roller-Smith Co.
Struthers-Dunn
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Capacity-Operated
Electronic Lab.
Luxtrol Co., Inc.

RELAYS, Circuit Control
Advance Electric Co.
Allen-Bradley Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Automatic Switch Co.
Brown Inst. Co.
Clare & Co.
Electric Controller
Friez & Sons
General Elec. Co.
Guardian Elec. Mfg. Co.
H-B Electric
Industrial Timer Corp.
Kellogg Switchboard
Leach Relay Co.
Lumenite Elec. Co.
Miller Co., Bertrand F.
Minneapolis-Honeywell
Monitor Controller Co.
Paragon Electric Co.
Roller-Smith Co.
Sigma Instruments, Inc.
Struthers-Dunn
United Cinephone Corp.
Ward Leonard Elec. Co.
Western Electro-Mech.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Continuous Current
Allen-Bradley Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Clare & Co.
General Elec. Co.
(Cont'd)

RELAYS, Continuous Current (Cont'd)
Guardian Elec. Mfg. Co.
H-B Electric
Industrial Timer Corp.
Kellogg Switchboard
Paragon Electric Co.
Struthers-Dunn
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Control
Allen-Bradley Co.
Advance Electric Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Automatic Switch Co.
Barber-Coleman
Betts & Betts
Brown Inst. Co.
Clare & Co.
Cutler-Hammer, Inc.
Electric Controller
Friez & Sons
General Controls Co.
General Elec. Co.
Guardian Elec. Mfg. Co.
Hagan Corp.
H-B Electric
Industrial Eng. Corp.
Kellogg Switchboard
Miller Co., Bertrand F.
Minneapolis-Honeywell
Monitor Controller Co.
National Time & Signal
Perfex Corp.
Precision Therm.
Roller-Smith Co.
Struthers-Dunn
United Cinephone Corp.
Ward Leonard Elec. Co.
Western Electro-Mech.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Demand Totalizing
Autocall Co.
General Elec. Co.
Hagan Corp.
Therm-Electric Meters Co
United Cinephone Corp.
Westinghouse Elec. & Mfg.

RELAYS, Electromagnetic
Advance Electric Co.
Allen-Bradley Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
(Cont'd)

RELAYS, Electromagnetic (Cont'd)
Automatic Switch Co.
Bender Warrick
Bunnell & Co.
Eby, Inc.
Clare & Co.
Cutler-Hammer, Inc.
Friez & Sons
General Elec. Co.
G-M Labs.
Guardian Elec. Mfg. Co.
H-B Electric
Industrial Eng. Corp.
Kellogg Switchboard
Kurman Electric Co.
Leach Relay Co.
Miller Co., Bertrand F.
Minneapolis-Honeywell
Monitor Controller Co.
National Time & Signal
Penn Electric Switch Co.
Perfex Corp.
Phila. Thermometer Co.
Precision Therm. & Inst.
Sigma Instruments, Inc.
Struthers-Dunn
United Cinephone Corp.
Ward Leonard Elec. Co.
Western Electro-Mech.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
White-Rodgers Electric
Zenith Electric Co.

RELAYS, Frequency
Autocall Co.
Clare & Co., C. P.
Cutler-Hammer, Inc.
Esterline-Angus Co.
Hickok Electrical Inst.
United Cinephone Corp.
Ward Leonard Electric Co.
Westinghouse Elec. & Mfg.

RELAYS, Galvanometer
Autocall Co.
Eby, Inc., Hugh H.
G-M Laboratories, Inc.
Roller-Smith Co.
Rubicon Co.
Tagliabue Mfg. Co., C. J.

RELAYS, Heavy Duty
Allen-Bradley Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Automatic Switch Co.
Cutler-Hammer, Inc.
General Elec. Co.
H-B Electric
Miller Co., Bertrand F.
Monitor Controller Co.
Penn Electric Switch
Philadelphia Thermometer
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Zenith Electric Co.

RELAYS, Instrument Controlled
American Automatic Elec.
American Inst. Co.
Autocall Co.
Brown Inst. Co.
Clare & Co.
Cramer & Co., Inc.
Friez & Sons
General Elec. Co.
Guardian Elec. Mfg. Co.
H-B Electric
Kurman Electric Co.
Minneapolis-Honeywell
Perfex Corp.
Phila. Thermometer Co.
Precision Therm.
Roller-Smith Co.
Struthers-Dunn
Tagliabue Mfg. Co.
Triplett Electrical Inst.
United Cinephone Corp.
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.

RELAYS, Light Sensitive (See Photoelectric below)

RELAYS, Magnetic (See Relays, Electro-Magnet)

RELAYS, Mercury
American Automatic Elec.
American Inst. Co.
Autocall Co.
Continental Elec. Co.
Guardian Electric
H-B Elec. Co., Inc.
Precision Therm.
Weston Elec. Inst. Corp.

RELAYS, Mercury Tube
American Inst. Co.
Autocall Co.
Brown Inst. Co.
Clare & Co.
General Controls Co.
G-M Labs.
Guardian Elec. Mfg. Co.
H-B Elec. Co., Inc.
Minneapolis-Honeywell
Phila. Thermometer
Precision Therm.
Struthers-Dunn
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.

RELAYS, Motor Driven Time Delay
Advance Electric Co.
American Inst. Co.
Betts & Betts
Controls, Inc.
Cramer & Co., Inc.
Struthers-Dunn
Friez & Sons
General Elec. Co.
Industrial Eng. Corp.
Industrial Timer
Monitor Controller Co.
Paragon Electric Co.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
Zenith Electric Co.

RELAYS, Movable Coil A.C.
Esterline-Angus Co.
General Elec. Co.
Roller-Smith Co.
Weston Elec. Inst. Corp.

RELAYS, Overload
Allen-Bradley Co.
Autocall Co.
Bunnell & Co.
Burlington Inst. Corp.
Cutler-Hammer, Inc.
Edison Electrical Controls
Electric Controller
General Elec. Co.
Guardian Elec. Mfg. Co.
Leach Relay Co.
Penn Electric Switch
Roller-Smith Co.
Standard Elect. Prods.
Struthers-Dunn
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.

RELAYS, Permanent Magnet Movable Coil
Bunnell & Co.
Esterline-Angus Co.
General Elec. Co.
Roller-Smith Co.
Triplett Electrical Inst.
Weston Elec. Inst. Corp.

RELAYS, Photoelectric
Advance Electric Co.
American Inst. Co.
Eby, Inc.
Clare & Co.
Continental Elec. Co.
Cutler-Hammer, Inc.
Dickson Co.
Electronic Lab.
Electronic Prod. Co.
Ess Instrument Co.
General Controls Co.
General Elec. Co.
G-M Labs.
Leach Relay Co.
Lipman Engg. Co.
Lumenite Elec. Co.
Photobell Corp.
Photoswitch, Inc.
Precision Therm.
Rehtron Corp.
Rubicon Co.
Sigma Instruments, Inc.
Tagliabua Mfg. Co.
United Cinephone Corp.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Polarized
American Automatic Elec.
Autocall Co.
Edison Electrical Controls
L. A. B. Corp.
Miller Co., Bertrand F.
Precision Therm. & Inst.
Struthers-Dunn
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Power
American Automatic Elec.
American Inst. Co.
Automatic Switch Co.
Esterline-Angus Co.
General Controls Co.
General Elec. Co.
Hagan Corp.
Roller-Smith Co.
Struthers-Dunn
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Power Factor
Esterline-Angus Co.
L. A. B. Corp.
Westinghouse Elec. & Mfg.

RELAYS, Resistance, D-c.
Advance Electric Co.
Autocall Co.
Automatic Electric Co.
Bunnell & Co.
Clare & Co., C. P.
Cutler-Hammer, Inc.
Dunn, Inc., Struthers
Guardian Electric
Leach Relay Co.

RELAYS, Stepping
Autocall Co.
Automatic Electric Co.
Dunn, Inc., Struthers
G-M Laboratories, Inc.
Guardian Electric
Roller-Smith Co.

RELAYS, Telephone Auxiliary Ringing
Advance Electric Co.
American Automatic Elec.
Autocall Co.
Clare & Co.
Kellogg Switchboard
Kurman Electric Co.
Leach Relay Co.
Struthers-Dunn
Western Electro-Mech.

RELAYS, Temperature
Autocall Co.
Clare & Co., C. P.
Dunn, Inc., Struthers
Edison Electrical Controls
Friez & Sons
Gleason-Avery, Inc.
G-M Laboratories, Inc.
Guardian Electric
Leach Relay Co.
Minneapolis-Honeywell
Photobell Corp.
Spencer Thermostat Co.
Tagliabue Mfg. Co., C. J.
United Cinephone Corp.
Westinghouse Elec. & Mfg.
Weston Electrical Inst.

RELAYS, Thermal Time Delay
Advance Electric Co.
Allen-Bradley Co.
American Automatic Elec.
Am. Gas Accumulator
American Inst. Co.
Autocall Co.
Automatic Temp. Control
Betts & Betts
Cramer & Co., Inc.
Cutler-Hammer, Inc.
Eagle Signal Corp.
Edison Electrical Controls
Electric Controller
Electronic Prod. Co.
Friez & Sons, Jr.
General Elec. Co.
Guardian Elec. Mfg. Co.
Industrial Eng. Corp.
Magnetic Gauge Co.
Paragon Electric Co.
Perfex Corp.
Photobell Corp.
Precision Therm.
Preferred Utilities Mfg.
Roller-Smith Co.
Spencer Thermostat Co.
Struthers-Dunn
Ward Leonard Elec. Co.
(Cont'd)

RELAYS, Thermal Time Delay (Cont'd)
Weston Elec. Inst. Corp.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
White-Rodgers Electric
Zenith Electric Co.

RELAYS, Time Delay (See Relays, Thermal Time Delay)

RELAYS, Transformer (Low Voltage)
Allen-Bradley Co.
Eclipse Aviation
Friez & Sons
General Controls Co.
Gleason-Avery, Inc.
Guardian Elec. Mfg. Co.
H-B Electric
Industrial Eng. Corp.
Miller Co., Bertrand F.
Minneapolis-Honeywell
Paragon Electric Co.
Penn Electric Switch
Perfex Corp.
Sigma Instruments, Inc.
Struthers-Dunn
Ward Leonard
Westinghouse Elec. & Mfg.
White-Rodgers Electric

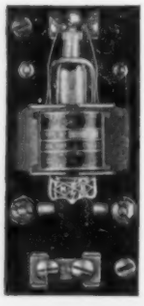
RELAYS, Vacuum Contact
American Automatic Elec.
American Inst. Co.
Edison Electrical Controls

RELAYS, Vacuum Tube
American Inst. Co.
Continental Elec. Co.
Eby, Inc.
Electro-Medical Lab.
Electronic Prod. Co.
General Controls Co.
General Elec. Co.
G-M Labs.
L. A. B. Corp.
Lumenite Elec. Co.
Photobell Corp.
Precision Therm.
Sargent & Co.
Sigma Instruments
Struthers-Dunn
Tagliabue Mfg. Co.
United Cinephone Corp.

AC RELAY

. . . IT'S AVAILABLE TODAY FROM STOCK

MERCURY TO MERCURY BREAK
MAINTENANCE FREE—DUST PROOF



This accurate unit has been tested to 10 million operations without a failure. Available up to 30 amps. or one horse power rating. It will operate within 45 degrees of vertical. Bulletin B gives full details; write for it today.

H-B ELECTRIC CO., INC.
Manufacturers of H B Electrical Devices
2513 NO. BROAD ST., PHILADELPHIA, PA.

AGASTAT

The Name for TIME-DELAY RELAY

An instantaneous recycling unit giving a delay interval ranging from a fraction of a second to several minutes, for use in electrical apparatus and equipment.

Positive, snap-action contacts, normally open, normally closed, or both. Single or double-pole. Offers a diversity of timing effects by different circuit combinations. Simple field adjustment. Unaffected by dust, temperature, humidity or voltage fluctuations.

Write Today for Bulletin N-4.

AMERICAN GAS ACCUMULATOR CO.
Electrical Division
ELIZABETH • NEW JERSEY

For addresses, see pages 82-91

RELAYS, Voltage
Advance Electric Co.
Allen-Bradley Co.
Autocall Co.
Automatic Switch Co.
Clare & Co., C. P.
Cutler-Hammer, Inc.
Dunn, Inc., Struthers
Eby, Inc., Hugh H.
Esterline-Angus Co.
Ferranti Electric, Inc.
Hart Manufacturing Co.
Hathaway Inst. Co.
Leach Relay Co.
Photobell Corp.
Reliance Instrument Co.
Roller-Smith Co.
Ward Leonard Electric Co.
Triplett Electrical Inst.
Westinghouse Elec. & Mfg.
Weston Electrical Inst.

REMOTE-CONTROL EQUIPMENT
Allen-Bradley Co.
American Automatic Elec.
Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Autocall Co.
Bailey Meter Co.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Builders Providence
Clare & Co.
Control Corp.
Cutler-Hammer, Inc.
Davis Reg. Co.
Elec. Indicator Corp.
Electrimatic Corp.
Electronic Lab.
Elsbert Mfg. Co.
Fischer & Porter
Foxboro Co.
General Elec. Co.
Guardian Electric
Hagan Corp.
Hanlon-Waters, Inc.
Hart Mfg. Co.
Hays Corp.
H-B Electric
Illinois Eng. Co.
International Filter Co.
Kollsman Inst. Co.
Kurman Electric Co.
Mason-Neilan Regulator
Minneapolis-Honeywell
Perfex Corp.
Photobell Corp.
Pioneer Instrument
Powers Regulator Co.
Republic Flow Meters
Scientific Inst. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
United Cinephone Corp.
Zenith Electric Co.

REMOTE-METERING EQUIPMENT, ELECTRICAL
Andrew, Victor J.
Automatic Temp. Control
Bristol Co.
Brown Inst. Co.
Builders-Providence
Control Corp.
Elec. Indicator Corp.
Elec. Tachometer Corp.
Esterline-Angus Co.
Fischer & Porter
Foxboro Co.
General Elec. Co.
W. & L. E. Gurley
Kellogg Switchboard
Kurman Electric Co.
L. A. B. Corp.
Leeds & Northrup Co.
Mason-Neilan Regulator
Moisture Register Co.
Morey & Jones, Ltd.
Pioneer Instrument
Republic Flow Meters
Tagliabue Mfg. Co.
Therm-Electric Meters
Westinghouse Elec. & Mfg.

REMOTE-METERING EQUIPMENT, HYDRAULIC
Builders-Providence
International Filter Co.
Leupold, Volpel & Co.
Westinghouse Elec. & Mfg.

REMOTE-METERING EQUIPMENT, PNEUMATIC
American Meter Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Foxboro Co.
Mason-Neilan Regulator
Taylor Inst. Cos.

RESISTANCE LOADING EQUIPMENT
Eastern Specialty Co.
Hardwick, Hindle, Inc.
International Resistance.
Precision Resistor Co.
Shallcross Mfg.
Ward Leonard

RESISTANCES
Allen-Bradley Co.
Beck Bros.
Central Scientific Co.
Clarostat Mfg. Co.
Cutler-Hammer, Inc.
Daven Co.
General Radio Co.
Instrument Resistors,
International Resistance
Mallory & Co.
(Cont'd)

RESISTANCES (Cont'd)
Ohmite Mfg. Co.
Precision Resistor Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Ward Leonard

RESISTORS, Adjustable
Mallory & Co.
Ward Leonard Electric Co.

RESISTORS, Carbon Compression
Allen Bradley Co.
Beck Bros.
International Resistance
Le Carbone Co., Inc.
Nat'l Carbon Co., Inc.
Ohio Carbon Co.
O. S. Peters
Speer Carbon Co.
Welch Mfg. Co.

RESISTORS, High Frequency
Beck Bros.
Daven Co.
General Radio Co.
Hardwick, Hindle, Inc.
Instrument Resistors, Inc.
International Resistance
Leeds & Northrup Co.
Mallory & Co.
Measurements Corp.
Ohmite Mfg. Co.
Shallcross Mfg. Co.
Ward Leonard Electric Co.

RESISTORS, High Voltage
Beck Bros.
Clarostat Mfg. Co.
Hardwick, Hindle, Inc.
Instrument Resistors, Inc.
International Resistance
J B L Instrument Co.
Ohmite Mfg. Co.
Shallcross Mfg. Co.
Ward Leonard Electric Co.

RESISTORS, Manganin
Beck Bros.
Daven Co.
General Radio Co.
Gray Instrument Co.
Hardwick, Hindle, Inc.
Instrument Resistors, Inc.
Leeds & Northrup Co.
Rubicon Co.
Shallcross Mfg. Co.

RESISTORS, Molded
Allen-Bradley Co.
Beck Bros.
Clarostat Mfg. Co.
International Resistance
Mutec Co.
Triplett Electrical Inst.

RESISTORS, Standard (See Standards, Resistance)

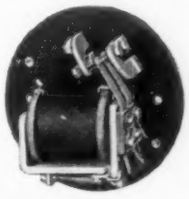
RELAYS by GUARDIAN

. . . for AC or DC Operation—

★Relays—Solenoids and Stepping Switches illustrated below suggest a few of the numerous types of Electrical Control Units obtainable at Guardian Electric, in both industrial and *Government Approved* types.

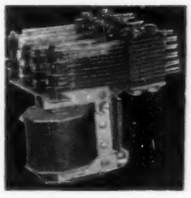
If you need COMPACT and highly sensitive controls that possess quick responsiveness and precision of action—with MAXIMUM CONTROL in *minimum space*—you will get it ALL at Guardian. Controls by Guardian are furnished to operate on any specified voltage up to 220 DC—440 AC—and on any current from .5 milliamperes to 30 amperes. Contact capacities to 1000 amperes, intermittent D.C.

DIRECT CURRENT RELAYS



Series 5 DC (left) Current draw as low as .009 watts—furnished completely enclosed—contact limit, double pole, double throw. Size 3¼x3¼x2"

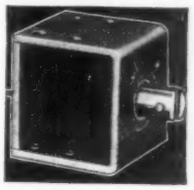
Series 115 DC (right) Four pole, double throw contact capacity, rapid change over of contacts, full floating, permanently locked armature, economical of space and cost.



ALTERNATING CURRENT RELAYS

SERIES 30 AC (left) Supplied in three types of mountings, voltage range .1 to 440 volts, contact capacity 42 contacts. Size 2⅜x1½x2½"

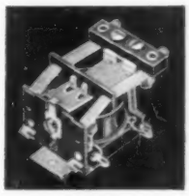
SOLENOIDS AC—DC



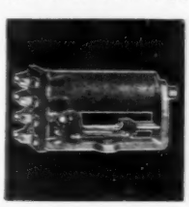
Type No. 2. Efficient—powerful—compact. For electromechanical operations involving remote control of mechanical motions such as electric counting, valve control and operation, faulty material ejection, automatic brake, electric ratcheting, etc. Size 1⅛x1½x1⅜".

GOVERNMENT APPROVED RELAYS

Series 195 Relay (left) Contact capacity 100 watts. Switch capacity double pole, double throw. Maximum coil resistance 3,000 Ohms. Vibration resistant. Specified where weight and size are of utmost importance, as in aircraft. Weight, ¾ oz. Size 15/16" Dia.x1¼"L. Available DC only.

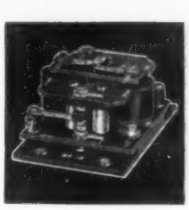


Series 165-24v. Vibration Resistant Relay (right). Contact combinations up to double pole, double throw, with contact capacity up to 12.5 amp. per pole, non-inductive AC. Overall dimensions: 2⅛x1-9/16x1⅝". Weight: (DPST contacts) 5 oz. Available DC only.



BK-10 RELAY (left) Precisely counter-balanced to resist extreme vibrations. Built to rigid U.S. Signal Corps specifications.

BK-16 RELAY (right) Built to minimum tolerances. A production line product. Furnished to custom-built specifications. Another U.S. Signal Corps Relay by Guardian.

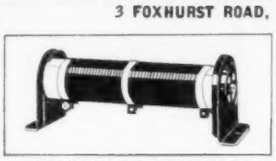


★ **WRITE TO GUARDIAN** for free engineering assistance on any electrical control problem. No obligation. Ask for Catalog L, with illustrations and specifications on the complete Guardian line.

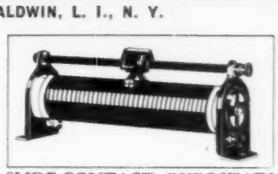
GUARDIAN ELECTRIC
1621 West Walnut Street Chicago, Illinois
LARGEST LINE OF RELAYS SERVING AMERICAN DEFENSE INDUSTRY

Rex Rheostat Co.

3 FOXHURST ROAD, BALDWIN, L. I., N. Y.



ADJUSTABLE RESISTORS
with and without protective housing. Cemented with heat, oil, acid and solvent resisting cement. 6 sizes — from 220 up to 1000 watt.



SLIDE-CONTACT RHEOSTATS
with and without protective housing. Laminated contact brush with *self-lubricating contacts.* 6 sizes — 120 different units. From .33 to 40,000 Ohms, from .08 to 25 Amps.

PROTECTED RHEOSTATS
protect the user and the rheostat. No tilting and dragging of the slider. Smooth operation. Accurate adjustment.

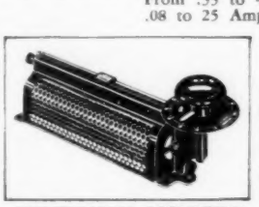
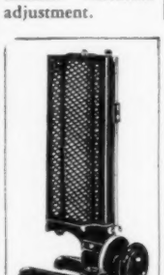


TABLE ROTARY DRIVE RHEOSTATS
with and without protective housing. No back lash. Angle of rotation: 330 deg. With dial. 2 sizes — 500 and 825 Watt.



VERTICALLY MOUNTED RHEOSTATS
with or without rotary drive, with or without protective housing.

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for switchboard mounting with or without protective housing. Cemented winding. Space saving design. Good heat dissipation. No back lash. Angle of rotation: 330 deg. Single Units—500 and 825 Watts. Double Units — 1000 and 1650 Watt.
Catalog upon request

For addresses, see pages 82-91

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Instrument Resistors, Inc.
International Resistance
Leeds & Northrup Co.
Mallory & Co.
National Electric Control.
Ohmite Mfg. Co.
Rex Rheostat Co.
Rubicon Co.
Shallcross Mfg.

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Biddle Co., Jas. G.
Clarostat Mfg. Co.
Cutler-Hammer, Inc.
Daven Co.
General Radio Co.
Gray Instrument Co.
Hardwick, Hindle, Inc.
Instrument Resistors, Inc.
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Ohmite Mfg. Co.
Rex Rheostat Co.
Rubicon Co.
Shallcross Mfg. Co.
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Beck Bros.
Cutler-Hammer, Inc.
Hardwick, Hindle, Inc.
International Resistance
National Elec. Controller
Ohmite Mfg. Co.
Rex Rheostat Co.
Schaefer Bros. Co.
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RHEOSTATS, Laboratory
Allen-Bradley Co.
American Inst. Co.
Beck Bros.
Biddle Co., Jas. G.
De Jur-Amsco Corp.
Central Scientific Co.
Chicago Apparatus Co.
Eastern Specialty Co.
General Radio Co.
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National Elec. Controller
Ohmite Mfg. Co.
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Rubicon Co.
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Hardwick, Hindle, Inc.
International Resistance
Leeds & Northrup
National Elec. Controller
Shallcross Mfg.
Ward Leonard Elec. Co.

RHEOSTATS, Slide Wire
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Central Scientific Co.
Chicago Apparatus Co.
General Radio Co.
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RULES, Drafting Room (See Drawing Instruments)

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RULES, Folding (Cont'd)
Post Co., Frederick
Speidel & Co.
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RULES, Glass
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Mico Instrument Co.

RULES, Parallel
Bliss & Co.
Dietzen Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.
Negus, T. S. & J. D.
Speidel & Co.
Warren-Knight Co.
White Co., Inc.
Weber Co.

RULES, Precision Standard
Gaertner Scientific Corp.

RULES, Shrinkage
Keuffel & Esser Co.
Lufkin Rule Co.
Speidel & Co.
Starrett Co.
Warren-Knight Co.
Weber Co.

RULES, Slide (See Drawing Instruments)

RULES, Slide, Psychrometric
Friez & Sons

RULES, Steel
Kern & Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Mico Instrument Co.
Millers Falls Co.
Scherr Co., Inc.
Speidel & Co.
Starrett Co.
Union Tool Co.
Warren-Knight Co.
Weber Co.

RULES, Wood
Henschel & Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Post Co., Frederick
Speidel & Co.
Warren-Knight Co.
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Eimer & Amend
Moeller Instrument Co.
Rieker Inst. Co.
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Rascher & Betzold
Rieker Inst. Co.
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Scientific Inst. Co.
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Scientific Inst. Co.
Tagliabue Mfg. Co.
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Westinghouse Elec. & Mfg.

SALINOMETERS (See Salinity Indicators)

SAMPLER, Boiler Water
Natl. Aluminate Corp.

SAMPLERS, Oil
Braun Corp.
Central Scientific Co.
Pgh. Equitable Meter Refinery Supply Co.
Scientific Glass Apparatus
Tagliabue Mfg. Co.

SAMPLERS, Oil Bottomhole
Ruska & Co., Inc.

SAMPLERS, Sewage
Builders-Providence
Central Scientific Co.
International Filter Co.
Scientific Glass Apparatus

SAMPLERS, Silt
Central Scientific Co.

SCALES (See also object of measurement)

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For addresses, see pages 82-91

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Sperry's

HYDRAULIC "EXACTOR CONTROL"

assures
the smallest movement being
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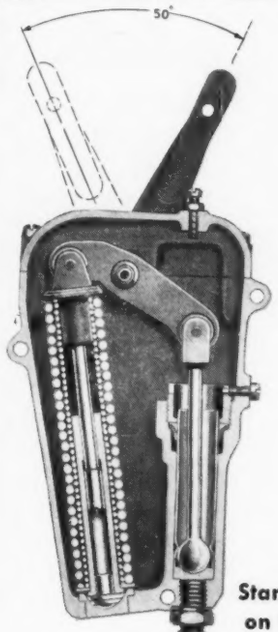
without backlash
Installation simple and rapid



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Pulleys, Bellcranks
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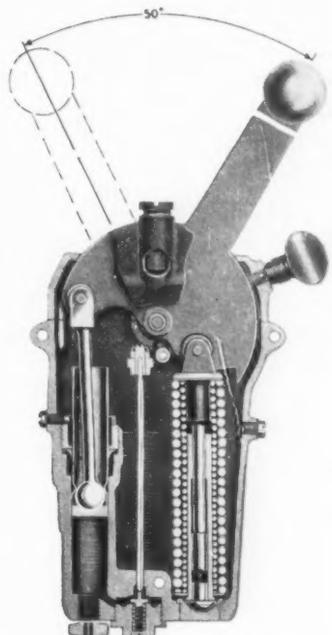

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Easily bent around obstructions

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Willow Ave., Hoboken, N. J.

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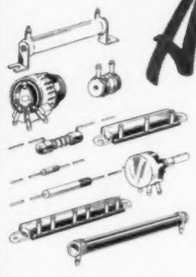

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Richardson Scale Co.
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Streeter-Amet Co.
Toledo Scale Co.
Triangle Package Mach.
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Exact Weight Scale Co.
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Gump Co.
Jacobs Bros. Co.
Kron Co.
Richardson Scale Co.
Toledo Scale Co.
Triangle Package Mach.

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Exact Scale Co.
Howe Scale Co.
Kron Co.
Seederer-Kohlbusch
Thwing-Albert Instrument
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.

SCALES, Bulk Weighing
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Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Jacobs Bros. Co.
Kron Co.
Merrick Scale Mfg.
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.
Triangle Package Mach.
Triner Sales Co.
Troemner, Henry

SCALE, Cement Batching
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Checking
Becker, Inc., Christian
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Jacobs Bros. Co., Inc.
Kron Co.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.

SCALES, Classifying
Exact Weight Scale Co.
Jacobs Bros. Co., Inc.
Kron Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Computing
Amthor Testing Inst.
Exact Weight Scale
International Bus. Mach.
Jacobs Bros., Inc.
Toledo Scale Co.
Triner Sales Co.

SCALES, Continuous Weighing
Buffalo Scale Co.
Builders-Providence
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Jacobs Bros. Co.
Jeffrey Mfg. Co.
Kron Co.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.
Triangle Package Mach.
United Cinephone Corp.

SCALES, Conveyor
Builders-Providence
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Kron Co.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Counting
Amthor Testing Inst. Co.
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Kron Co.
Seederer-Kohlbusch
Toledo Scale Co.
Triner Sales Co.
United Cinephone Corp.

SCALES, Crane
Buffalo Scale Co.
Chatillon & Sons
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.

SCALES, Dairy
Becker, Inc., Christian
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Humboldt Mfg. Co.
International Bus. Mach.
Jacobs Bros. Co.
Kron Co.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.
Troemner, Henry

SCALES, Differential
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Jacobs Bros. Co., Inc.
Kron Co.
Thwing-Albert Instrument

SCALES, Drawing (See Drawing Instruments)

SCALES, Dump
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Toledo Scale Co.

SCALES, Dynamometer
Central Scientific Co.
Chatillon & Sons
Dillon & Co.
Exact Weight Scale
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Martin Decker Corp.
Seederer-Kohlbusch, Inc.
Toledo Scale Co.

SCALES, Estimating
Exact Weight Scale Co.
Jacobs Bros. Co.
Seederer-Kohlbusch, Inc.
Troemner, Henry

SCALES, Grain & Seed Testing
Amthor Testing Inst. Co.
Automatic Scale Co.
Becker, Inc., Christian
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
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Gump Co.
Howe Scale Co.
Jacobs Bros. Co.
Kron Co.
Newark Scale Works
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.
Triangle Package Mach.
Triner Sales Co.
Troemner, Henry

SCALES, Hopper
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
Jacobs Bros. Co.
Kron Co.
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Laboratory
Becker, Inc., Christian
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Chicago Apparatus Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Fisher Scientific Co.
Howe Scale Co.
Humboldt Mfg. Co.
International Bus. Mach.
Jacobs Bros. Co.
Microchemical Service
Newark Scale Works
Seederer-Kohlbusch, Inc.
Toledo Scale Co.
Torsion Balance Co.
Troemner, Henry

SCALES, Larry Car
Buffalo Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Liquid
Jacobs Bros. Co., Inc.
Richardson Scale Co.

SCALES, Loss of Weight
Becker, Inc., Christian
Buffalo Scale Co.
Exact Weight Scale Co.
Jacobs Bros. Co.
Kron Co.
Seederer-Kohlbusch, Inc.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.

SCALES, Measuring
Automatic Scale Co.
Howe Scale Co.
Kron Co.
Richardson Scale Co.
Triner Sales Co.

SCALES, Over & Under
Becker, Inc., Christian
Buffalo Scale Co.
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Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Moisture Register Co.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.
Troemner, Henry

SCALES, Packaging
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Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
Kron Co.
International Bus. Mach.
Jacobs Bros. Co.
Pneumatic Scale Corp.
Richardson Scale Co.
Toledo Scale Co.
Torsion Balance Co.
Triangle Package Mach.
Triner Sales Co.
Troemner, Henry

SCALES, Platform
Becker, Inc., Christian
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
Humboldt Mfg. Co.
International Bus. Mach.
Knowles Scale Works
Kron Co.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.

SCALES, Portable
Black & Decker
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Exact Weight Scale
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Knowles Scale Works
Kron Co.
Richardson Scale Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Predetermined Weight
Becker, Inc., Christian
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
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Schaffer Poidometer Co.
Seederer-Kohlbusch, Inc.
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Torsion Balance Co.
Triner Sales Co.

SCALES, Recording
Buffalo Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.
Wallace & Tiernan

SCALES, Remote Indicating
Toledo Scale Co.

SCALES, Rolling Mill
Buffalo Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Sacking (See Scales, Bag-filling)

SCALES, Selecting
Exact Weight Scale
Toledo Scale Co.
United Cinephone Corp.

SCALES, Solder Test
Central Scientific Co.
Exact Weight Scale
Seederer-Kohlbusch, Inc.
Troemner, Henry

SCALES, Steel
Exact Weight Scale
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Lufkin Rule Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Testing
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Exact Weight Scale
Gump Co.
Howe Scale Co.
Humboldt Mfg. Co.
Jacobs Bros. Co.
Kron Co.
Newark Scale Works
Toledo Scale Co.
Torsion Balance Co.

SCALES, Textile
Becker, Inc., Christian
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Kron Co.
Saxl Instrument Co.
Seederer-Kohlbusch, Inc.
Streeter-Amet Co.
Suter, Alfred
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.

SCALES, Track
Buffalo Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Truck
Black & Becker
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Water Meter
Altender & Sons
Exact Weight Scale
Fairbanks, Morse & Co.
Jacobs Bros. Co.
Kron Co.
Toledo Scale Co.

SCALES, Yardage
Amthor Testing Inst.
Brown & Sharpe
Buffalo Scale Co.
Exact Weight Scale
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Kron Co.
Toledo Scale Co.

SCREENS, Solar Projecting
Fecker, J. W.

SCREENS, X-Ray Fluoroscopic
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Taylor Inst. Cos.
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SERVO-MOTORS, Electric Motor
Brown Inst. Co.
Eclipse Aviation
General Regulator Corp.
L. A. B. Corp.
Minneapolis-Honeywell

SERVO-MOTORS, Electric Solepoid
Brown Inst. Co.
Eclipse Aviation
Ruggles-Klingemann

SERVO-MOTORS, Hydraulic
Askania Regulator Co.
Eclipse Aviation
General Regulator Corp.
Hagan Corp.
Mason-Neilan Regulator
Ruggles-Klingemann

SERVO-MOTORS, Mechanical
Hagan Corp.

SERVO-MOTORS, Pneumatic
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Brown Inst. Co.
Hagan Corp.
Mason-Neilan Regulator
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Negus, T. S. & J. D.
Pioneer Instrument Co.
Warren-Knight Co.
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Kenyon Instrument Co.
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Pitometer Log Corp.

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General Elec. Co.
Hickok Elec. Inst. Co.
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Precision Resistor Co.
Radio City Products Co.
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Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg.
Triplett Electrical Inst.
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Esterline-Angus Co.
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Gray Instrument Co.
Hickok Electrical Inst.
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Roller-Smith Co.
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Clark & Sons
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Foxboro Co.
General Elec. Co.
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National Time & Signal
Sangamo Electric Co.

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SLIDING GAGES (See Gages, Sliding)

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SMOOTHNESS RECORDERS (See Surface Finish Analyzers)

SOLAR PROJECTING SCREEN (See Screen, Solar Projecting)

SOUND INDICATORS & ANALYZERS (See Indicators, Sound & Analyzers, Sound)

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Clough-Brengle Co.
Daven Co.
De Jur-Amsco Corp.
Electrical Research Prod.
Electronic Design Corp.
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Radio City Products Co.
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Sound Apparatus Co.
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Kuner Co., Max
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Negus, T. S & J. D.

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SPECTRO-PHOTOMETERS (See Photometers, Spectro)

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SPEED, Regulators (See Controllers, Automatic, Tachometric)

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Solar Mfg. Corp.

STANDARDS, Color
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Hellige, Inc.
Munsell Color Co.
Tagliabue Mfg. Co.

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Leeds & Northrup Co.
Rubicon Co.

STANDARDS, Frequency
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Ferris Inst. Corp.
General Radio Co.
RCA Manufacturing
Warren Telechron Co.

STANDARDS, Inductance
Cambridge Inst. Co.
General Radio Co.
Leeds & Northrup Co.
Rubicon Co.

STANDARDS, Length
Gaertner Scientific Corp.
Gurley, W. & L. E.
Van Keuren Co.

STANDARDS, Mass
Gurley, W. & L. E.
Seederer-Kohlbusch, Inc.

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Rubicon Co.

STANDARDS, Pressure
Green, Henry J.
Precision Therm.

STANDARDS, Resistance
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Cambridge Inst. Co.
General Radio Co.
International Resistance
Leeds & Northrup Co.
Rubicon Co.
Shallcross Mfg. Co.
Sticht & Co.
Ward Leonard Elec. Co.

STANDARDS, Sound Level
General Radio Co.

STANDARDS, Temperature
Green, Henry J.
Leeds & Northrup Co.
Moeller Instrument Co.
Precision Therm.
Tagliabue Mfg. Co.

STANDARDS, Time
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General Radio Co.
Standard Elec. Time Co.
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STANDARDS, Volume
Gurley, W. & L. E.

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Area Regulators, Inc.
Elec. Indicator Corp.
General Elec. Co.
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STELLAR SPECTROSCOPES (See Spectroscopes, Stellar)

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Bausch & Lomb Optical
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Test-A-Tone Co.

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STRAIN TESTERS, GLASS (See Testers, Strain (Glass)

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Cambridge Inst. Co.

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Morey & Jones, Ltd.

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Martin Decker Corp.
Riehle Div.

STRESS-STRAIN, Indicators
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STRESS-STRAIN, Recorders
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Cambridge Inst. Co.
Olsen Testing Machine
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Commercial Engg. Labs.
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Westinghouse Elec. & Mfg.
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SULPHUR BOMBS (See Bombs, Sulphur)

SULPHUR DIOXIDE, Indicators (See Gas Analyzers, Sulphur Dioxide) Recorders (See Gas Analyzers, Sulphur Dioxide)

SUNSHINE, Indicators & Recorders
Cambridge Inst. Co.
Esterline-Angus Co.
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Bristol Co.
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Cramer & Co., Inc.
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Physicists Research

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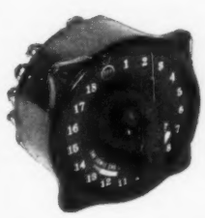
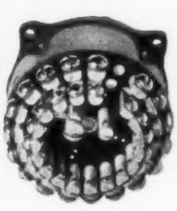

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Hart Mfg. Co.
Monitor Controller Co.
Ward Leonard Elec. Co.
Zenith Electric Co.

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General Elec. Co.
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Mallory & Co.
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Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg.
Thwing-Albert Instrument
Triplett Elec. Inst. Co.
United States Inst. Corp.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

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Perfex Corp.
Struthers-Dunn
Ward Leonard Elec. Co.
Zenith Electric Co.

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Frederick, George
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Gen. Elec. Lamp Dept.
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Brown Inst. Co.
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Lewis Engg. Co.
Tagliabue Mfg. Co.
Thwing-Albert Inst. Co.
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SWITCHES, Relay
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Amer. Automatic Elec.
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Daven Co.
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Tagliabue Mfg. Co.
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Triplett Electrical Inst.
Weston Elec. Inst. Corp.

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Cutler-Hammer, Inc.
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Hart Mfg. Co.
Mallory & Co.
McDonnell & Miller
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Minneapolis-Honeywell
Perfex Corp.
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Automatic Elec. Mfg.
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Betts & Betts
Cramer & Co., Inc.
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Edison Electrical Controls
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SYNCHRONOUS MOTORS (See Motors, Synchronous)

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Roller-Smith Co.
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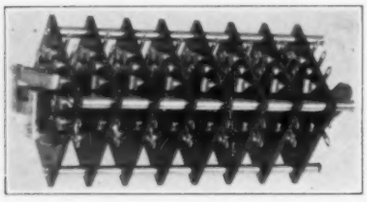

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Corbin Screw Corp.
Durant Mfg. Co.
Elec. Tachometer Corp.
Foxboro Co.
Hays Corp.
Jones Motrola Sales
Knopf, Paul
Kollsman Inst. Co.
Manning, Maxwell & Moore
Pioneer Instrument Co.
Scherr Co., Inc.
Stewart-Warner Corp.
Sticht & Co.
Veeder-Root, Inc.
Viking Instrument Co.
Zernickow Co., O.

TACHOMETERS, Chronometric
Amthor Testing Inst.
Biddle Co., Jas. G.
Boulin Instrument Corp.
Coats Mach. Tool Co.
Cramer & Co., Inc.
Elec. Tachometer Corp.
Elgin Nat'l Watch Co.
Hasler-Tel Co.
Jaeger Watch Co.
Pierce Watch Co.
Scherr Co., Ino.
Standard Elec. Time
Sticht & Co.
Stover-Lang Co.
Zernickow Co., O.

TACHOMETERS, Cross-pendulum
Amthor Testing Inst.
Biddle Co., Jas. G.
Coats Mach. Tool Co.
Sticht & Co.
Zernickow Co., O.

TACHOMETERS, Electric
Bristol Co.
Brown Inst. Co.
Electric Speed Ind. Co.
Elec. Tachometer Corp.
Esterline-Angus Co.
Foxboro Co.
General Elec. Co.
Hathaway Inst. Co.
Hickok Elec. Inst. Co.
Hy-Ef Electrical Prods.
Jaeger Watch Co.
J-B-T Instruments
Jones Motrola Sales
Kollsman Inst. Co.
Lantz-Phelps Corp.
Martin Decker Corp.
Moisture Register Co.
National Instrument Co.
Pioneer Instrument Co.
Pitometer Log Corp.
Potter Co.
Scherr Co., Inc.
Sticht Co., Inc.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
Winslow Co.
Zip Abrasive Co.

TACHOMETERS, Electromagnetic
Cummings Mach. Works
Electric Auto-Lite
Jaeger Watch Co.
Kollsman Inst. Co.
National Instrument Co.
Pioneer Instrument
Standard Elec. Time Co.
Stewart-Warner Corp.
Zernickow Co., O.

TACHOMETERS, Fly-ball
Biddle Co., Jas. G.
Coats Mach. Tool Co.
Elec. Tachometer Corp.
Jones Motrola Sales
Sticht & Co.
Viking Instrument Co.

TACHOMETERS, Portable
Amthor Testing Inst. Co.
Associated Research
Biddle Co., Jas. G.
Boulin Instrument Corp.
Corbin Screw Corp.
Elec. Tachometer Corp.
Foxboro Co.
Hasler-Tel Co.
Jones Motrola Sales
Manning, Maxwell & Moore
Martindale Electric Co.
Rieker Instrument Co.
Sticht & Co.
Viking Instrument Co.
Zernikow Co.

TACHOMETERS, Speed Limit Control
Barbour Stockwell Co.

TACHOMETERS, Stroboscopic
Boulin Instrument Corp.
Coats Mach. Tool
General Radio Co.
L. A. B. Corp.
Stewart-Warner Corp.

TACHOMETERS, Tilting-ring
Amthor Testing Inst. Co.
Coats Mach. Tool Co.
Zernikow Co.

TACHOMETERS, Vibrating Reed
Biddle Co., Jas. G.

TACHOSCOPES
Amthor Testing Inst. Co.
Biddle Co., Jas. G.
Scherr Co., Inc.
Sticht & Co.
Zernickow Co., O.

TAFFRAIL LOGS; SHIP
Bliss & Co.

TANGENT METERS (See Meters, Tangent)

TAPE STRETCHER APPARATUS
Ballauf Mfg. Co.

TAPES, Oil Gauger's
Keuffel & Esser Co.

TAPES, Steel
Dietzen Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Soltmann, Inc.
Speidel & Co.
Starrett Co.
United States Blue Print
Warren-Knight Co.
Weber Co.
White Co. Inc.

TAPES, Surveyor's (See Surveying Instruments)

TAXI METERS
Knopf, Paul
Ohmer Register Co.
Pittsburgh Taximeter Co.

TELEMETERING SYSTEMS (See Remote Metering)

TELEMETERS (Surveying & Military—Optical)
Kern Co.
Kollmorgen Optical Co.
Keuffel & Esser Co.
Pierce Watch Co.

TELESCOPES, Alignment
Am. Telescope Labs.
Fecker, J. W.
Gen. Engg. & Model
Keuffel & Esser Co.
Kollmorgen Optical Co.
Perkin-Elmer Corp.
Ruska & Co.
Scherr Co., Inc.
Unertl, John
White Co. Inc.

TELESCOPES, Astronomical
Am. Telescope Labs.
Bausch & Lomb Opt.
Clark & Sons
Eastern Science Co.
Fecker, J. W.
Gaertner Scientific Corp.
Kern Co.
Mico Instrument Co.
Perkin-Elmer Corp.
Tinsley Labs.
Unertl, John
Zeiss, Inc., Carl

TELESCOPES, Azimuth
Am. Telescope Labs.
Clark & Sons
Fecker, J. W.
Gaertner Scientific Corp.
Kern Co.
Kollmorgen Optical Co.
Perkin-Elmer Corp.
Tinsley Labs.
Unertl, John
Warren-Knight Co.
Warner & Swasey Co.
Zeiss, Inc., Carl

TELESCOPES, Bore & Internal Surface, Inspection
American Cystoscope
Am. Telescope Labs.
Fecker, J. W.
Gaertner Scientific
Gen. Engg. & Model Wks.
Kollmorgen Optical Co.
Lenox Inst. Co.
Perkin-Elmer Corp.
Scherr Co. Inc.
Unertl, John
Zeiss, Inc., Carl

TELESCOPES, Laboratory
Gaertner Scientific Corp.
Ruska & Co.

TELESCOPES, Reflecting
Am. Telescope Labs.
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Perkin-Elmer Corp.
Tinsley Labs.
Unertl, John
Warner & Swasey Co.
Zeiss, Inc., Carl

TELESCOPES, Refracting
Am. Telescope Labs.
Bausch & Lomb Opt.
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Kern Co.
Keuffel & Esser Co.
Perkin-Elmer Corp.
Tinsley Labs.
Unertl, John
Warner & Swasey Co.
Wollensak Optical Co.
Zeiss, Inc., Carl

TELESCOPES, Zenith
American Askania Corp.
Am. Telescope Labs.
Clark & Sons
Fecker, J. W.
Gaertner Scientific Corp.
Kern Co.
Perkin-Elmer Corp.
Unertl, John
Zeiss, Inc., Carl

TENSIOMETERS
Boulin Instrument Corp.
Central Scientific Co.
Geophysical Inst. Co.
Olsen Testing Machine
Suter, Alfred
Thwing-Albert
Toledo Scale Co.

TENSION INDICATORS
Martin Decker Corp.
Pacific Scientific Co.
Seederer-Kohlbusch, Inc.

TENSION INDICATORS, Textile
Boulin Instrument Corp.

TEST BLOCKS
Detroit Testing Mach. Co.
Eitzen Co.
Ford Motor Co.
Meter Devices Co.
Steel City Testing Lab.
Van Keuren Co.

TEST INDICATOR
Deming Indicator Co.
Reich Mfg. Co.

TEST WEIGHTS (See Weights, Test)

TEST WELLS
Palmer Co.
Tagliabue Mfg. Co.

TESTERS, Tachometer
Rieker Inst. Co.

TESTERS & TESTING MACHINES (See also object of measurement and control)

TESTERS & TESTING MACHINES, Abrasion
American M. A. N. Corp.
Amthor Testing Inst. Co.
Atlas Elec. Devices Co.
Fidelity Mach. Co.
Morehouse Machine Co.
Olsen Testing Machine
Riehle Div.
Saxl Inst. Co.
Scott Co., Henry L.
Shawmut Engineering Co.
Suter, Alfred
Taber Instrument Co.
Testing Machines, Inc.
Welch Engineering Co.
Zuhr, Inc., Henry

TESTERS & TESTING MACHINES, Absorption
Gurley, W. & L. E.

TESTERS & TESTING MACHINES, Air Speed Indicator (See Air-speed Indicator Testers)

TESTERS & TESTING MACHINES, Alternating Stress
American M. A. N. Corp.
Brush Development Co.
Krouse Fatigue Machine
Olsen Testing Machine
Riehle Div.
Suter, Alfred

TESTERS & TESTING MACHINES, Altimeter (See Altimeter Testers)

TESTERS & TESTING MACHINES, Armature
Ideal Commutator Dresser

TESTERS & TESTING MACHINES, Asphalt
American Inst. Co.
Atlas Electric Devices
Brabender Corp.
Braun Corp.
Central Scientific Co.
Chatillon & Sons
Exact Weight Scale
Fish-Schurman Co.
Fisher Scientific Co.
Humboldt Mfg. Co.
Philadelphia Thermometer
Precision Scientific Co.
Riehle Div.
Tagliabue Mfg. Co.
Victor Equipment Co.
Western Machinery Co.

TESTERS & TESTING MACHINES, Axle
Sperry Products, Inc.

TESTERS & TESTING MACHINES, Ball Bearing (See Testers, Bearing)

TESTERS & TESTING MACHINES, Battery
Burton-Rogers Co.
Clough-Brengle Co.
Hickok Elec. Inst. Co.
Hy-Ef Electrical Prods.
Lantz-Phelps Corp.
Lundquist Tool & Mfg.
Precision Therm.
Rascher & Betzold
Rieker Inst. Co.
Ruth Glass Division
Testrite Instrument Co.
Weston Elec. Inst. Corp.

TESTERS & TESTING MACHINES, Beating
Brabender Corp.
Paprex Co.
Williams Apparatus Co.

TESTERS & TESTING MACHINES, Bearing
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Olsen Testing Machine
RCA Manufacturing Co.
Suter, Alfred

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Saxl Inst. Co.
Steel City Testing Lab.
Suter, Alfred
Taber Instrument Co.
Testing Machines, Inc.

TESTERS & TESTING MACHINES, Brake
American Inst. Co.
Clough-Brengle Co.
Commercial Engg. Labs.
Cramer & Co., Inc.

TESTERS & TESTING MACHINES, Brinell
Detroit Testing Mach.
Ferner Co.
King, Andrew
Olsen Testing Machine
Pittsburgh Inst. & Mach.
Riehle Div.
Steel City Testing Lab.
Suter, Alfred
Testing Machines, Inc.

TESTERS & TESTING MACHINES, Brittleness
Baldwin-Southwark Corp.
Riehle Div.
Saxl Instr. Co.

TESTERS & TESTING MACHINES, Bursting
Perkins & Son, Inc.
Scott Co., Henry L.
Suter, Alfred
Testing Machines, Inc.

TESTERS & TESTING MACHINES, Cable
Amthor Testing Inst.
Atlas Electric Devices
Boulin Instrument Corp.
General Elec. Co.
Leeds & Northrup Co.
Martin Decker Corp.
Olsen Testing Machine
Riehle Div.
Rubicon Co.
Scott Co., Henry L.
Shallcross Mfg. Co.
Suter, Alfred

TESTERS & TESTING MACHINES, Cement
American Inst. Co.
Baldwin-Southwark Corp.
Burrell Tech. Supply
Central Scientific Co.
Exact Weight Scale Co.
Federal Pneumatic Sys.
(Cont'd)

TESTERS & TESTING MACHINES, Cement (Cont'd)
Fisher Scientific Co.
Hayes Scientific App.
Humboldt Mfg. Co.
Olsen Testing Machine
Precision Scientific Co.
Refinery Supply Co.
Riehle Div.
Scientific Inst. Co.
Scott Co., Henry L.
Sodemann Heat & Power
Suter, Alfred
Western Machinery Co.

TESTERS & TESTING MACHINES, Chain
Detroit Testing Machine
Riehle Div.

TESTERS & TESTING MACHINES, Chlorine
Bushnell & Nevins
Everson Mfg. Co.
Hellige, Inc.
Industrial Inst. Inc.
Rascher & Betzold
Taylor & Co., Inc.
Wallace & Tiernan

TESTERS & TESTING MACHINES, Coal (See Fuel below)

TESTERS & TESTING MACHINES, Coil (Electric)
Boonton Radio Corp.
Clough-Brengle Co.
Ideal Commutator Dresser
Industrial Insts. Inc.
Rubicon Co.

TESTERS & TESTING MACHINES, Color
Atlas Electric Devices Co.
Elmer & Amend
Fisher Scientific Co.
Gaertner Scientific Corp.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Compression
American M. A. N. Corp.
Baldwin-Southwark Corp.
Dorr-Patterson Engr. Co.
Exact Weight Scale Co.
Ferner Co.
Olsen Testing Machine
Perkins & Son, Inc.
Potter Co.
RCA Manufacturing
Riehle Div.
Scott Co., Henry L.
Steel City Testing Lab.
Suter, Alfred
Toledo Scale Co.

TESTERS & TESTING MACHINES, Concrete (See Cement above)

TESTERS & TESTING MACHINES, Condenser
Aerovox Corp.
Clough-Brengle Co.
Electronic Design Corp.
Industrial Insts. Inc.
Jackson Electrical Inst.
Potter Co.
Rubicon Co.
Tobe Deutschmann Corp.
Triplett Electrical Inst.
Weston Elec. Inst. Corp.

TESTERS & TESTING MACHINES, Creep
Gaertner Scientific Corp.
Instrument Specialties Co.
Olsen Testing Machine
Riehle Div.
Suter, Alfred

TESTERS & TESTING MACHINES, Damping
American M. A. N. Corp.
Baldwin-Southwark Corp.

TESTERS & TESTING MACHINES, Deflection
Instrument Specialties

TESTERS & TESTING MACHINES, Deflection, Light Wave
Gaertner Scientific Corp.
Van Keuren Co.

TESTERS & TESTING MACHINES, Dew Point
General Electric
Refinery Supply Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Diaphragms
Instrument Specialties

TESTERS & TESTING MACHINES, Dielectric Properties
American Transformer Co.
Associated Research, Inc.
Leeds & Northrup Co.
Miller Co., H. F.
Roller-Smith Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Ductility
Central Scientific Co.
Detroit Testing Mach.
Humboldt Mfg. Co.
Olsen Testing Machine
Riehle Div.
Saxl Inst. Co.
Scott Co., Henry L.
Steel City Testing Lab.
Suter, Alfred

For addresses, see pages 82-91

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Baldwin-Southwark Corp.
Ferner Co.
Hathaway Inst. Co.
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Olsen Testing Machine
Raytheon Mfg. Co.
Ruehfel Co.
Saxl Inst. Co.
Scott Co., Henry L.
Suter, Alfred
Testing Machines, Inc.
Zuhr, Inc., Henry

TESTERS & TESTING MACHINES, Flash Point, Abel's
Central Scientific Co.
Ruehfel Co.

TESTERS & TESTING MACHINES, Flash Point, Abel-Pensky's (See Abel's above)

TESTERS & TESTING MACHINES, Flash Point, Cleveland Open Cup
American Inst. Co.
Boekel & Co.
Central Scientific Co.
Eimer & Amend
Humboldt Mfg. Co.
Olsen Testing Machine
Precision Scientific Co.
Ruehfel Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Flash Point, Elliott Closed Cup
American Inst. Co.
Central Scientific Co.
Humboldt Mfg. Co.
Precision Scientific Co.
Ruehfel Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Flash Point, Pensky-Martens
Boekel & Co.
Central Scientific Co.
Humboldt Mfg. Co.
Precision Scientific Co.
Ruehfel Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Flash Point, Tag Closed
Central Scientific Co.
Humboldt Mfg. Co.
Precision Scientific Co.
Ruehfel Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Flatness, Light Wave
Baird Associates
Fecker, J. W.
Fish-Schurman Co.
Gaertner Scientific Co.
Scherr Co., Inc.
Van Keuren Co.
Zeiss, Inc., Carl

TESTERS & TESTING MACHINES, Folding Endurance (Paper)
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Amthor Testing Inst. Co.
Olsen Testing Machine
Saxl Inst. Co.
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Thwing-Albert Inst. Co.

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Dietert Co.
Paprex Co.
Testing Machines, Inc.
Williams Apparatus Co.

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Central Scientific Co.
Emerson Apparatus Co.
Fish-Schurman Co.
Fisher Scientific Co.
Parr Instrument Co.
Riehle Div.
Sargent & Co.

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TESTERS & TESTING MACHINES, Gas
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Burrell Technical Supply
Central Scientific Co.
Connelly Iron Sponge
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Fish-Schurman Co.
Fisher Scientific Co.
Friez & Sons
Fuess, Inc.
Gow-Mac Instrument
Heiland Research
Refinery Supply Co.
Ruska & Co., Inc.
Sargent & Co.
Superior Meter Co.

TESTERS & TESTING MACHINES, Gear
Morse Twist Drill
Scherr Co., Inc.

TESTERS & TESTING MACHINES, Glue
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Eimer & Amend
Fish-Schurman Co.
Olsen Testing Machine
Saxl Inst. Co.

TESTERS & TESTING MACHINES, Grain
Central Scientific Co.
Exact Weight Scale
Gump Co.
Moist-O-Meter, Inc.
Moisture Register Co.
Newark Scale Works
Tagliabue Mfg. Co.
Toledo Scale Co.
Troemner, Henry

TESTERS & TESTING MACHINES, Grease (See Grease Testing Apparatus)

TESTERS & TESTING MACHINES, Grinding Wheel
Olsen Testing Machine

TESTERS & TESTING MACHINES, Ground Resistance
Biddle Co., Jas. G.
Geophysical Inst. Co.
Heiland Research
Industrial Insts. Inc.
Shallcross Mfg.
Sticht & Co.

TESTERS & TESTING MACHINES, Gummed Tape
Amthor Testing Inst.
Scott Co., Henry L.
Thwing-Albert Inst. Co.

TESTERS & TESTING MACHINES, Hardness
Barber-Colman Co.
Detroit Testing Mach.
Dietert Co.
Eitzen Co.
Ferner Co.
Fisher Scientific Co.
Gogan Machine
King, Andrew
Leitz, Inc.
Olsen Testing Machine
Pittsburgh Inst. & Mach.
Riehle Div.
Saxl Inst. Co.
Shore Instrument
Steel City Testing Lab.
Suter, Alfred
Tetweld, Inc.
Testing Machines, Inc.
Wilson Mech Inst. Co.
Zeiss, Inc., Carl

TESTERS & TESTING MACHINES, Hardness of Grindable Materials
Brabender Corp.

TESTERS & TESTING MACHINES, Hardness of Plastic Films
Munsell Color Co.
Saxl Inst. Co.
Steel City Testing Lab.
Taber Instrument Co.
Testing Machines, Inc.

TESTERS & TESTING MACHINES, High Pressure, for Hose Lines & hydraulic devices
Hydraulic Controls

TESTERS & TESTING MACHINES, Hydrogen-Ion (See Hydrogen Ion Determination Instruments)

TESTERS & TESTING MACHINES, Impact
Baldwin-Southwark Corp.
Cambridge Inst. Co.
Impact Register Co.
Olsen Testing Machine
Riehle Div.
Saxl Inst. Co.
Scott Co., Henry L.
Steel City Testing Lab.
Testing Machines, Inc.
Thwing-Albert Inst.
Saxl Inst. Co.
Zuhr, Inc., Henry

TESTERS & TESTING MACHINES, Initial Tearing
Scott Co., Henry L.
Suter, Alfred
Testing Machines, Inc.
Thwing-Albert Inst. Co.

TESTERS & TESTING MACHINES, Insulation
Associated Research
Biddle Co., Jas. G.
Clough-Brengle Co.
General Elec. Co.
General Radio Co.
Ideal Commutator Dresser
Industrial Insts. Inc.
Leeds & Northrup Co.
Martindale Electric Co.
Miller Co., Bertrand F.
Rawson Electrical Inst.
Rubicon Co.
Scott Co., Henry L.
Shallcross Mfg. Co.
Sticht Co., Inc.
United Transformer Corp.

TESTERS & TESTING MACHINES, Insulation (Thickness)
Comtor Co.
General Elec. Co.
Instrument Specialties Co.

TESTERS & TESTING MACHINES, Jelly
Brabender Corp.
Chatillon & Sons
Fish-Schurman Co.
Saxl Inst. Co.

TESTERS & TESTING MACHINES, Knit Goods (See Textile below)

TESTERS & TESTING MACHINES, Leather
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Central Scientific Co.
Olsen Testing Machine
Perkins & Son
Riehle Div.
Saxl Inst. Co.
Scott Co., Henry L.

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Rubicon Co.

TESTERS & TESTING MACHINES, Malt
Brabender Corp.
Rieker Instrument Co.

TESTERS & TESTING MACHINES, Mileage (See Meters, Mileage)

TESTERS & TESTING MACHINES, Milk
Central Scientific Co.
Eimer & Amend
Munsell Color Co. Inc.
Rieker Inst. Co.
Ruehfel Co.
Ruth Glass Division
Scientific Glass App.
Testrite Instrument Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Moisture
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American Inst. Co.
American Moistening Co.
Brabender Corp.
Cambridge Inst. Co.
Central Scientific Co.
Delmhorst, Wm. J.
Dietert Co.
Eimer & Amend
Exact Weight Scale
Fisher Scientific Co.
Fuess, Inc.
Hart Moisture Gages
Humboldt Mfg. Co.
Industrial Inst. Inc.
Moist-O-Meter, Inc.
Moisture Register Co.
Precision Scientific Co.
Rascher & Betzold
Refinery Supply Co.
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Sodeman Heat & Power
Tagliabue Mfg. Co.
Testing Machines, Inc.
Thwing-Albert Inst. Co.
Toledo Scale Co.
Troemner, Henry
Williams Apparatus Co.

TESTERS & TESTING MACHINES, Oil
American Inst. Co.
American M. A. N. Corp.
Brabender Corp.
Central Scientific Co.
Eimer & Amend
Fish-Schurman Co.
Hellige, Inc.
Humboldt Mfg. Co.
Mico Instrument Co.
Precision Scientific Co.
Rieker Inst. Co.
Ruehfel Co.
Ruska & Co.
Ruth Glass Division
Scientific Glass App.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Western Machinery Co.

TESTERS & TESTING MACHINES, Oxygen
Burrell Technical Supply
Eimer & Amend
Sargent & Co.
Scientific Glass App.
Scientific Inst. Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Paint
Akatos, Inc.
Atlas Elec. Devices Co.
Central Scientific Co.
Fish-Schurman Co.
Munsell Color Co.
Ruehfel Co.
Saxl Instr. Co.
Scott Co., Henry L.
Taber Instrument Co.
Van Keuren Co.
Zuhr, Inc., Henry

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American Inst. Co.
Amthor Testing Inst. Co.
Atlas Elec. Devices
Central Scientific Co.
Eimer & Amend
Federal Prod. Corp.
Ferner Co.
Fuess, Inc.
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Olsen Testing Machine
Perkins & Son
Riehle Div.
Saxl Inst. Co.
Scott Co., Henry L.
Speidel & Co.
Steel City Testing
Taber Instrument Co.
Toledo Scale Co.
Van Keuren Co.
Williams Apparatus Co.

TESTERS & TESTING MACHINES, Paper Formation
Fuess, Inc.
Paprex Co.
Saxl Inst. Co.
Thwing-Albert Inst. Co.
Williams Apparatus Co.

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American Inst. Co.
Perkins & Son
Ruehfel Co.
Tagliabue Mfg. Co.

TESTERS & TESTING MACHINES, Penetration (Paper)
Saxl Inst. Co.
Testing Machines, Inc.
Thwing-Albert Inst. Co.
Williams Apparatus Co.

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TESTERS & TESTING MACHINES, Pipe & Tube
Baldwin-Southwark Corp.
Black & Decker
Olsen Testing Machine

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Fuess, Inc.
Kollmorgen Optical Co.
Lenox Inst. Co.
Scherr Co., Inc.

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Eimer & Amend
Olsen Testing Machine
Precision Scientific Co.
Saxl Inst. Co.
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Steel City Testing
Testing Machines, Inc.

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Fuess, Inc.
Gurley, W. & L. E.
Ruska & Co., Inc.
Saxl Inst. Co.
Testing Machines, Inc.
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Brabender Corp.
Perkins & Son
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Hickok Electrical Inst.
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Million Radio & Television
Monarch Manufacturing
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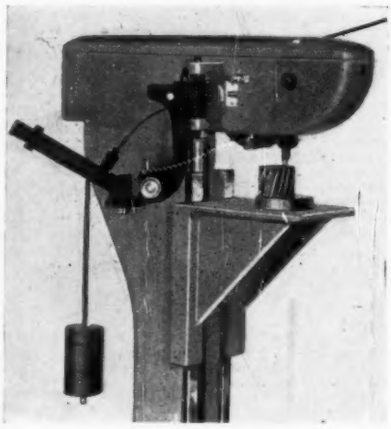

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Scott Co., Henry L.
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Suter, Alfred
Steel City Testing
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Saxl Inst. Co.
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Steel City Testing
Suter, Alfred
Taber Instrument Co.

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Fecker, J. W.
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Gaertner Scientific Corp.
General Elec. Co.
Kollmorgen Optical Co.
Pfaltz & Bauer, Inc.
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Zeiss, Inc., Carl

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Thwing-Albert Inst. Co.
Suter, Alfred

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Biddle Co., Jas. G.
Consol. Ashcroft Hancock
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Hayward, H. N.
Pioneer Instrument
Standard Elec. Time
Stucht Co., Inc.
Zeiss, Inc., Carl
Zernickow Co., O.

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Scott Co., Henry L.
Speidel & Co.
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Humboldt Mfg. Co.
Precision Scientific Co.
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Atlas Elec. Devices Co.
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Suter, Alfred
Taber Instrument Co.
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Suter, Alfred
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States Co.
Western Electro-Mech.
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Riehle Div.

TESTING MACHINES, UNIVERSAL, Dead weight beam, Capacities 5000-100,000 lb.
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Olsen Testing Machine
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Detroit Testing Machine
Riehle Div.
Steel City Testing Lab.

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Olsen Testing Machine
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Scott Co., Henry L.
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Steel City Testing
Suter, Alfred

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Olsen Testing Machine
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Toledo Scale Co.

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Ruehfel Co.
Scientific Glass App.
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Engelhard, Chas.
Gow-Mac Instrument
Hays Corp.
Hy-Ef Electrical Prod.
Niehoff & Co.
Potter Co.

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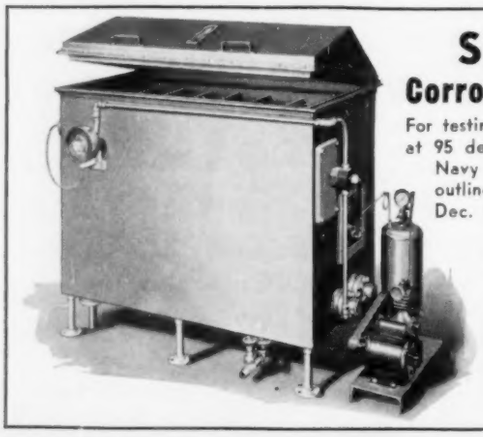
Eastern Specialty Co.
Elec. Facilities Inc.
Leeds & Northrup
Rubicon Co.
West. Electro-Mechanical



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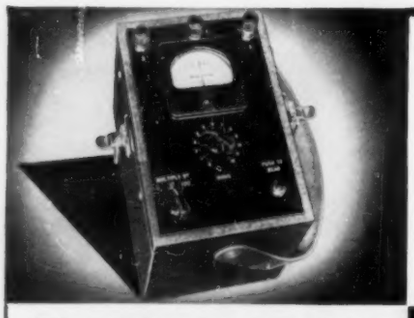

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For addresses, see pages 82-91

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Tagliabue Mfg. Co.
Thwing-Albert Instrument

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Heiland Research
Industrial Inst., Inc.
Niagara Elec. Inst.
Roller-Smith Co.
Sensitive Research Inst.
Shallcross Mfg.
Sticht Co., Inc.

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Ferranti Electric, Inc.
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J B L Instrument Co.
Leeds & Northrup Co.
Miller Co., B. F.
Rubicon Co.
Sicht Co., Inc.
Weston Electrical Inst.

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Meter Devices Co.
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General Elec. Co.
Hathaway Instrument
RCA Manufacturing Co.
Roller-Smith Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
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Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

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Tagliabue Mfg. Co.

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Dwyer Mfg. Co.
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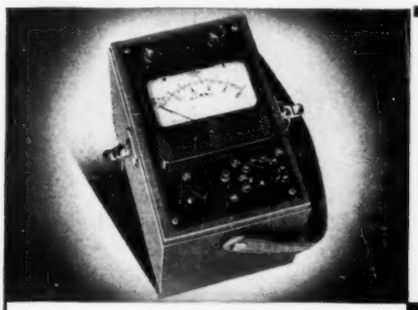

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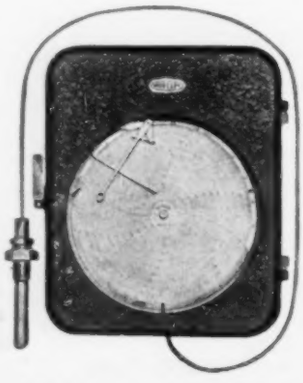

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THERMOMETER TESTERS (See Testers, Thermometer)

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Am. Temperature Ind.
Bailey Meter Co.
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Thwing-Albert Instrument
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Tagliabue Mfg. Co.
Taylor Inst. Cos.
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U. S. Gauge Co.
Wagner & Son
Weksler Thermometer
Western Machinery Co.
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THERMOMETERS, Indicating, Mercury-in-Glass, Industrial & Laboratory
Ace Glass, Inc.
Accuracy Scientific Inst.
Bristol Co.
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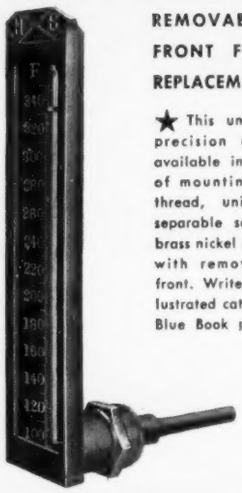

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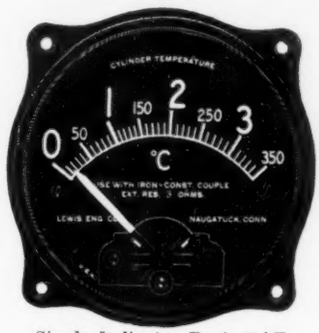
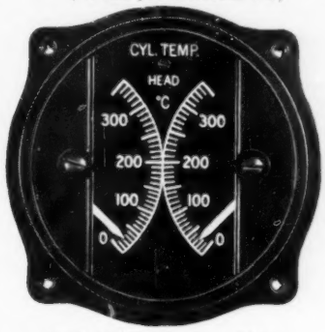
ENGINE CYLINDER TEMPERATURE INDICATORS—THERMOCOUPLE TYPE

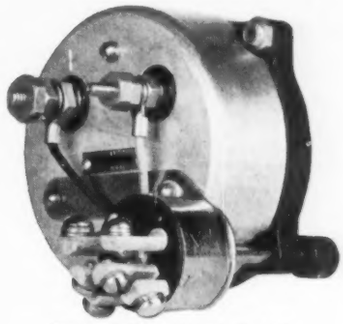
(Write for Bulletin 1-2)



Single Indicator Part 17AT



Dual Indicator Part 96AT



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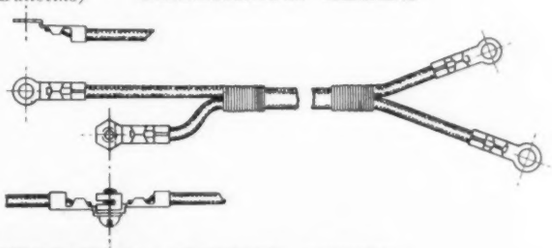

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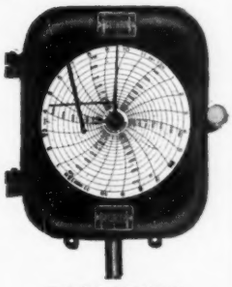

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Trerice Co.
Wagner & Son

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THERMO-VOLTMETERS (See Voltmeters, Thermo)

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Seely Instrument Co.
Service Recorder Co.
Simplex Time Recorder
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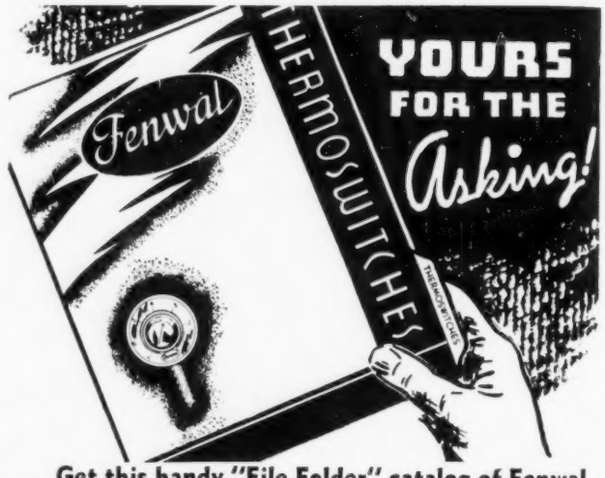

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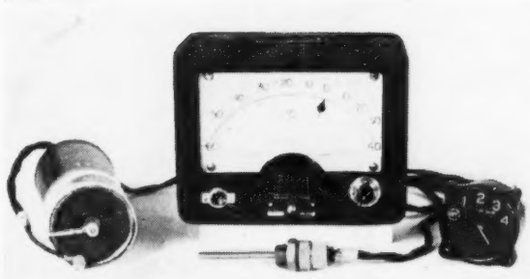

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Warren Telechron Co.
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Automatic Time Stamp
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Bristol Co.
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Guardian Elec. Mfg. Co.
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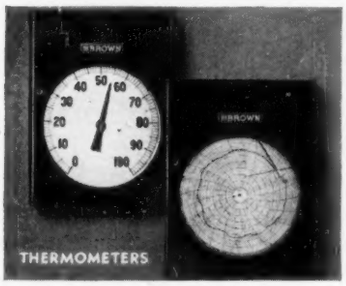

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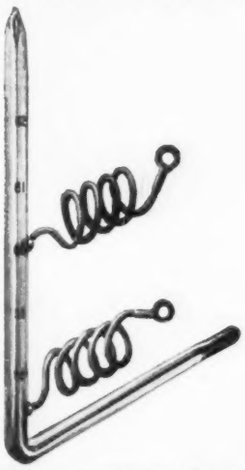

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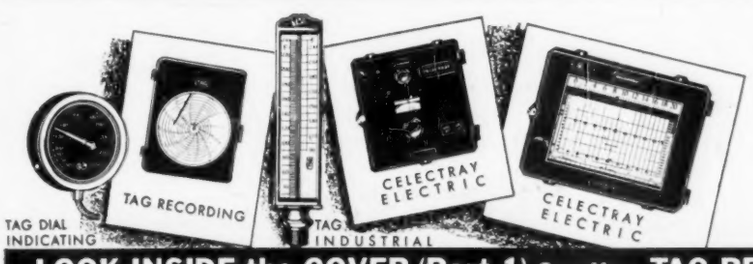

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Zenith Electric Co.

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Am. Timer Corp.
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Automatic Temp. Control
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National Technical Labs.
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Sargent & Co., E. H.
Thomas Co., Arthur H.
Welch Mfg. Co.

TOOLMAKER'S FLATS
Bausch & Lomb Opt.
Fecker, J. W.
Pratt & Whitney
Ruska & Co.
Van Keuren Co.
Zeiss, Inc., Carl

TOPOGRAPHIC INSTRUMENTS (See Surveying Instruments)

TORQUE GAGES (See Gages, Torque)

TORQUE MEASURING EQUIPMENT
Waugh Laboratories

TORSIOGRAPH
Baldwin-Southwark Corp.
Commercial Engr. Labs.

TORSION METERS
Boulin Inst. Corp.
Cummings Mach. Works
Kurman Electric Co.
McNab of Bridgeport
Riehle Div.
Saxl Inst. Co.
Toledo Scale Co.

TOTALIZERS, Demand
American Meter Co.
General Elec. Co.
Therm-Electric Meters Co.
United Cinephone Corp.
Westinghouse Elec. & Mfg.

TOTALIZERS, Electric Energy
Autocall Co.
Esterline-Angus Co.
General Elec. Co.
Therm-Electric Meters Co.
Westinghouse Elec. & Mfg.

TOTALIZERS, Fluid Flow
American Meter Co.
Bailey Meter Co.
Brown Inst. Co.
Fischer & Porter
Foxboro Co.
Henszey Co.
Leupold, Voipel & Co.
Mason-Neilan Regulator
Republic Flow Meters
Tagliabue Mfg. Co.
Taylor Inst. Cos.

TOTALIZERS, Gas Flow
American Meter Co.
Fischer & Porter

TOTALIZERS, Running Time
Cramer & Co., Inc.
Elec. Tachometer Corp.
Photoswitch, Inc.
Production Instrument
United Cinephone Corp.
Westinghouse Elec. & Mfg.

TRAFFIC SIGNALING DEVICES (See Signaling Devices, Traffic)

TRAMMELS, Steel Beam
Union Tool Co.

TRANSFORMERS, Adjustable
General Radio Co.
Superior Electric Co.

TRANSFORMERS, Constant Voltage
Sola Electric Co.

TRANSFORMERS, Experimenter's Variable Voltage
Dongan Electric Mfg.

TRANSFORMERS, Instrument
Amplifier Co.
Annis Co.
Associated Research
Columbia Elec. Mfg.
Davis & Co.
Dongan Electric Mfg.
Elec. Facilities, Inc.
Esterline-Angus Co.
Friez & Sons
General Elec. Co.
Hickok Elec. Inst. Co.
Industrial Engr. Corp.
Lipman Engg. Co.
Miller Co., Bertrand F.
Nothelfer Winding Labs.
Roller-Smith Co.
Sangamo Electric Co.
Thordarson Elec. Co.
United Transformer Corp.
West, Electro-Mechanical
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

TRANSFORMERS, Insulation Testing
Campbell Electric
Dongan Electric Mfg.
Nothelfer Winding Labs.

TRANSFORMERS, Laboratory
American Transformer
Amplifier Co.
Burrell Tech. Supply
Central Scientific Co.
Clough-Brengle Co.
Daven Co.
Davis & Co.
Dongan Electric Mfg.
Eastern Specialty Co.
Elec. Facilities, Inc.
General Elec. Co.
General Radio Co.
Halldorson Co.
Standard Elec. Prods.
Miller Co., Bertrand F.
Nothelfer Winding Labs.
Raytheon Mfg. Co.
Sola Electric Co.
Superior Electric Co.
Thordarson Elec. Co.
United Transformer Corp.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

TRANSFORMERS, Phasing
Davis & Co.
Dongan Electric Mfg.
Eastern Specialty Co.
Stan[illegible] Co.
Thordarson Mfg. Co.
United Transformer Corp.
Westinghouse Elec. & Mfg.

TRANSFORMERS, Power
Amplifier Co.
Ferranti Electric

TRANSFORMERS, Split Core
Annis Co.
Davis & Co.
Elec. Facilities, Inc.
General Elec. Co.
H-D Elec. Co.
Industrial Eng. Corp.
Roller-Smith Co.
Rubicon Co.
Sangamo Electric Co.
Thordarson Elec. Co.
United Transformer Corp.
Western Electro-Mech.
Westinghouse Elec. & Mfg.

TRANSFORMERS, Variable Voltage Testing
American Transformer
Dongan Electric Mfg.
Superior Electric Co.

TRANSITS, Astronomical
American Askania Corp.

TRANSITS, Engineer's (See Surveying Instruments)

TRANSITS, Pocket
Ainsworth & Sons
Keuffel & Esser Co.
Mico Instrument Co.
Speidel & Co.
Warren-Knight Co.
White Co., Inc.

TRUCK MILEAGE RECORDERS (See Meters, Mileage)

TRUCK-TIME RECORDERS
Cramer & Co., Inc.
Durant Mfg. Co.
Knopf, Paul
Ohmer Register Co.
Service Recorder Co.

TRUCK, TIME & MILEAGE RECORDERS
Cramer & Co., Inc.
Ohmer Register Co.
Sangamo Electric Co.

TUBES (See also Gas & Vapor Discharge Tubes)

TUBES, Cathode Ray (See Cathode Ray Tubes)

TUBES, Nessler (See Nessler Tubes)

TUBES, Oil Centrifuge (See Oil Centrifuge Tubes)

TUBES, Photoelectric
Continental Electric Co.
General Electric Co.
General Scientific Corp.
Photobell Corp.
RCA Manufacturing
United Cinephone Corp.
Vacutron, Inc.

TUBES, Pitot (See Flowmeters, Pitot Tube)

TUBES, Polariscope
Akatos, Inc.
American Inst. Co.
Bausch & Lomb Optical
Central Scientific Co.
Eimer & Amend
Fecker, J. W.
Gaertner Scientific Corp.
Hellige, Inc.
Jarrell-Ash Co.
Precision Scientific Co.
Sargent & Co.
Woermann-Schuchhardt

TUBES, Precision Bore (See Precision Bore Glass Tubing)

TUBES, Pyrometer
Bristol Co.
Brown Inst. Co.
Eitzen Co.
Elematic Sales Corp.
Fish-Schurman Corp.
Hoskins Mfg. Co.
Illinois Testing Labs.
Leeds & Northrup Co.
Tagliabue Mfg. Co.
Taylor Instrument Cos.

TUBES, Spectrum (See Spectrum Tubes)

TUBES, Ultra-Violet Light (See Ultra-Violet Light Sources)

TUBES, Vacuum
Arcturus Radio Tube Co.
Central Scientific Co.
Federal Telegraph
Fredericks, George
General Elec. Co.
General Scientific Corp.
General Television Corp.
Raytheon Mfg. Co.
RCA Manufacturing Co.
Vacutron, Inc.
Wheelco Inst. Co.

TUBES, Venturi (See Flowmeters, Venturi)

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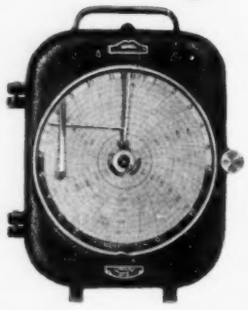

Left:
Portable Recorder
6 inch Chart
24 hour Clock

Right:
Dial Thermometer
In 3½, 4, 4½, 5 and
6 inch Dial Sizes

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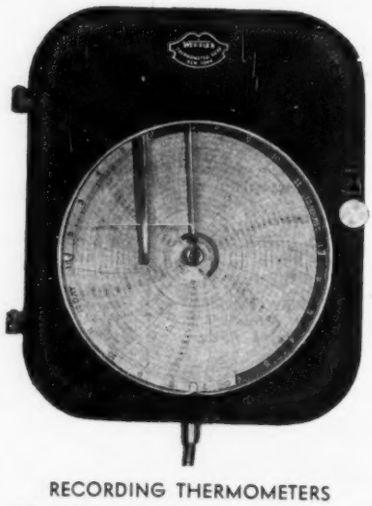
Type 103
Bronze Case,
Glass Front,
Industrial



Catalog 115
Laboratory
Thermometers
and
Hydrometers

RECORDING THERMOMETERS
Furnished with 6", 10" or 12" Charts

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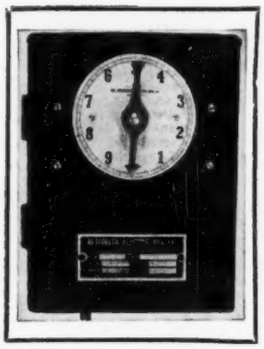
For others, send for Catalog No. 115.

Weksler Thermometer Corporation
52-56 WEST HOUSTON STREET, NEW YORK, N. Y.

For addresses, see pages 82-91



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Models for

Any desired time cycle
Any function specified
Any performance wanted

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INTERVAL TIMERS, or PROCESS TIMERS, are furnished in two types. One is reset by hand (manually); other resets itself automatically. Both types can be provided for practically any cycle of time, fully adjustable from zero to maximum period. SYNCHRONOUS, SELF-STARTING MOTORS.

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Used extensively for starting and stopping industrial work; school class periods; for municipal time signals, etc. Up to six signal periods, permanently set at factory with Sunday & Holiday Cutout and Manual Control, at a price of only $35.

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Triple Pole • Double Pole • Single Pole

All three types can be furnished with capacities ranging from 20 TO 200 AMPERES PER POLE, from $12.00 up. Ten ampere Time Switches from $3.95 up.

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MANKATO, MINNESOTA

Conserve Laboratory "Man-Hours"
WITH THIS
AUTOMATICALLY - CONTROLLED TIMER!

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● During these days of rapid production, precision timing tests cannot lag—in speed or in accuracy. Standaro Electric Stop Clocks, through automatic measurement of time intervals, release man power for other duties during the test period. What's more, the accuracy of testing is increased by the elimination of the human error. Several models, ranging in measurement intervals from .01 second to one hour—adaptable to all types of industrial timing. Large dial, easy to read. Rugged, trouble-proof construction throughout. For literature and details of 30-day FREE Trial Offer write

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"STANDARD MAKES EVERY SPLIT-SECOND COUNT"

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American Inst. Co.
Baird Associates
Corning Glass Works
General Electric X-Ray
Jarrell-Ash Co.
Kelley-Koett Mfg.
Westinghouse X-Ray Co.
Wyland, George

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Eimer & Amend
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Fisher Scientific Co.
Hellige, Inc.
Klett Mfg. Co.
Kimble Glass Co.
Parr Instrument Co.
Pfaltz & Bauer, Inc.
Photoswitch, Inc.
Photovolt Corp.
Precision Scientific Co.
Rawson Electrical Inst.
Rubicon Co.
Sensitive Research Inst.
Zeiss, Inc., Carl

TURN & BANK INDICATORS
Kollsman Inst. Co.
Pioneer Instrument

TURN INDICATOR TESTERS (See Testers, Turn Indicator)

TWIST COUNTERS (See Counters, Twist)

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Gen. Elec. Lamp Dept.
Hanovia Chem. & Mfg. Co.

ULTRA-VIOLET LIGHT SOURCES (See Light Sources)

U-TUBE MANOMETERS (See Manometers)

VACUUM GAGES, Hot-Wire
Baird Associates
Continental Elec. Co.
Fuess, Inc.
General Elec. Co.
Xervac Inst. Co.

VACUUM GAGES, Ionization
Fredericks, George
General Elec. Co.
General Television Corp.

VACUUM GAGES, Liquid-column
American Meter Co.
Bacharach Industrial Inst.
Defender Automatic Reg.
Dubrovin, John
Gas Appliance Specialties
Lantz-Phelps Corp.
Meriam Co.
Moeller Inst. Co.
Pioneer Instrument
Precision Term. & Inst.
Scientific Glass Apparatus
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Uehling Instrument Co.

VACUUM GAGES, McLeod
Ace Glass, Inc.
Central Scientific Co.
Eimer & Amend
General Elec. Co.
General Physical Lab.
Macalaster Bicknell Co.
Scientific Glass Apparatus
Stokes Machine Co.
Welch Mfg. Co.

VACUUM GAGES, Pirani Type
Distillation Products

VACUUM, Indicators
American Meter Co.
Ashton Valve Co.
Bailey Meter Co.
Baird Associates
Bristol Co.
Brown Inst. Co.
Central Scientific Co.
Clapp Instrument
Eimer & Amend
Foxboro Co.
Fredericks, George
General Elec. Co.
Kollsman Inst. Co.
Manning, Maxwell & Moore
Marsh Corp.
Mason-Neilan Regulator
Moeller Instrument Co.
Pioneer Instrument
Potter Co.
Precision Therm.
Rawson Electrical Inst.
Republic Flow Meters
Rochester Mfg. Co.
Scientific Glass Apparatus
Star Brass Mfg. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Uehling Instrument Co.

VACUUM, HIGH (below 1 mu) Controllers, Indicators & Recorders
Baird Associates
Continental Elec. Co.
Eimer & Amend
Electronic Prod. Co.
General Elec. Co.
General Physical Lab.
Welch Mfg. Co.

VACUUM RECORDERS
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Ashton Valve Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Dickson Co.
Esterline-Angus Co.
Foxboro Co.
Fredericks, George
Manning, Maxwell & Moore
Marsh Corp.
Mason-Neilan Regulator
Republic Flow Meters
Scientific Instrument Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Uehling Instrument Co.

VACUUM SPECTROGRAPHS (See Spectrographs, Vacuum)

VACUUM TUBES (See Tubes, Vacuum)

VACUUM TUBE BRIDGES (See Bridges, Vacuum Tube)

VACUUM TUBE RELAYS (See Relays, Vacuum Tube)

VACUUM TUBE VOLTMETERS (See Voltmeters, Vacuum Tube)

VALVE BOX FINDER (See Finder, Valve Box)

VALVE-OPERATING DEVICES, Electric Motor
Baldwin-Southwark Corp.
Barber-Coleman Co.
Beck Co.
Brown Inst. Co.
Cramer & Co., Inc.
Cutler-Hammer, Inc.
Dickson Co.
Foxboro Co.
General Controls Co.
Hays Corp.
Illinois Eng. Co.
Jenkins Bros.
McAlear Mfg. Co.
Ruggles-Klingemann
Tagliabue Mfg. Co.

VALVE OPERATING DEVICES, Electric Solenoid (See Valves, Solenoid)

VALVE OPERATING DEVICES, Hydraulic (See Valves, Hydraulically Operated)

VALVE-OPERATING DEVICES, Pneumatic (See Valves, Diaphragm)

VALVE POSITION INDICATORS
Autocall Co.
Automatic Temp. Control
Bailey Meter Co.
Barber Coleman
Beck Co.
Bendix Marine Products
Builders-Providence
Elec. Indicator Corp.
Elec. Tachometer Corp.
Foxboro Co.
General Regulator Corp.
Hanlon-Waters, Inc.
Leupold, Volpel & Co.
Manning, Maxwell & Moore
Merco Nordstrom Valve
Northern Equip. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Tefft-Jackson, Inc.
Westinghouse Elec. & Mfg.

VALVES, Automatic Shut-off
Automatic Switch Co.
Automatic Valve Control
Barber Coleman
Belfield Co.
Brown Inst Co.
Davis Reg. Co.
Fisher Governor Co.
Foster Engg. Co.
Frick Co.
Friez & Sons
General Controls Co.
General Sales & Prod.
Hanlon-Waters, Inc.
Jergu son Gage Co.
Kiely & Mueller
McAlear Mfg. Co.
McDonnell & Miller
Merco Nordstrom Valve
Minneapolis-Honeywell
Partlow Corp.
Ruggles-Klingemann
Payne Furnace & Supply
Schade Valve Mfg. Co.
Tagliabue Mfg. Co.
Wilgus Mfg. Co.

VALVES, Automatic Solenoid
(See Valves, Solenoid)

TIMERS

● SINGLE OR MULTIPLE CONTACT CYCLE TIMERS—Continuous repeat action or instantaneous reset types. Accurate timing adjustment of individual circuits and of complete cycle.

Also:

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- IMPULSE TIMERS
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- FLASHERS
- SIGNAL CONTROLS

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● TIME DELAY SWITCHES OR RELAYS—Thermostatically controlled or motor driven; for any voltage, any load, any application.

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For addresses, see pages 82-91

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Foxboro valves for air-operated controllers should be specified with Foxboro Controllers—because the characteristic of the Valve should fit the characteristic of the instrument. The Valve is a vital part of a Control installation. The Foxboro line is engineered to assure the best results.

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VALVES, Balanced
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Atlas Valve Co.
Bailey Meter Co.
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Belfield Co.
Boylston Co.
Bristol Co.
Cash Co.
Cochrane Corp.
Connelly Iron Sponge
Davis Reg. Co.
Defender Automatic Reg.
D'Este Co.
Fisher Governor Co.
Ford Reg. Valve Co.
Foster Engg. Co.
General Controls Co.
Hanlon-Waters, Inc.
Illinois Eng. Co.
Jenkins Bros.
Kiely & Mueller
Klipfel Mfg. Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
Minneapolis-Honeywell
Natural Gas Equipment
Northern Equip. Co.
Powers Regulator Co.
Republic Flow Meters
Reynolds Gas Regulator
Ruggles-Klingemann
Schade Valve Mfg. Co.
Seely Instrument Co.
Spence Engineering Co.
Tagliabue Mfg. Co.
Watts Regulator Co.
Wilgus Manufacturing

VALVES, Constant Pressure
Bailey Meter Co.
Belfield Co.
Cash Co.
Connelly Iron Sponge
Davis Reg. Co.
D'Este Co.
Fisher Governor Co.
Foster Engg. Co.
Hanlon-Waters, Inc.
Hoke, Inc.
Jenkins Bros.
Klipfel Mfg. Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
Northern Equipment
Powers Regulator Co.
Refrigerating Spec. Co.
Reynolds Gas Regulator
Ruggles-Klingemann
Schade Valve Mfg. Co.
Spence Engineering Co.
Tagliabue Mfg. Co.
Vaughn-G E. Witt Co.
Wilgus Manufacturing

VALVES, Diaphragm
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Bastian-Blessing Co.
Belfield Co.
Boylston Co.
Bristol Co.
Brown Inst. Co.
Cash Co.
Connelly Iron Sponge
Davis Reg. Co.
Defender Automatic Reg.
D'Este Co.
Fisher Governor
Foster Engg. Co.
Foxboro Co.
General Controls Co.
Hanlon-Waters, Inc.
Illinois Eng. Co.
Johnson Service Co.
Kiely & Mueller
Klipfel Mfg. Co.
Leslie Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg. Co.
McCorkle Co.
Minneapolis-Honeywell
National Airoil Burner
Natural Gas Equipment
Partlow Corp.
Payne Furnace & Supply
Powers Regulator Co.
Refrigerating Spec. Co.
Republic Flow Meters Co.
Reynolds Gas Regulator
Ruggles-Klingemann
Schade Valve Mfg. Co.
Scientific Instrument Co.
Seely Instrument Co.
Spence Engineering Co.
Spencer Thermostat Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Vaughn-G E. Witt
White-Rodgers Electric
Wilgus Manufacturing

VALVES, Electrically Operated
Atkins & Co.
Atlas Valve Co.
Automatic Products Co.
Automatic Switch Co.
Automatic Temp. Control
Barber Coleman
Bristol Co.
Brown Inst. Co.
Cochrane Corp.
Cutler-Hammer, Inc.
Davis Reg. Co.
(Cont'd)

VALVES, Electrically Operated (Cont'd)
Defender Automatic Reg.
Electric Valve Mfg.
Electrimatic Corp.
Foster Engg. Co.
Foxboro Co.
Frick Co.
Friez & Sons
General Controls Co.
Hannifin Mfg. Co.
Hunt & Son
Illinois Eng. Co.
Jenkins Bros.
Kiely & Mueller
Klipfel Mfg. Co.
Leslie Co.
Magnatrol Valve Corp.
Manning, Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg. Co.
McCorkle Co.
McDonnell & Miller
Merco Nordstrom Valve
Minneapolis-Honeywell
Northern Equipment Co.
Payne Furnace & Supply
Penn Electric Switch
Perfex Corp.
Refrigerating Spec. Co.
Ruggles-Klingemann
Schade Valve Mfg. Co.
Shallcross Mfg. Co.
Spence Engineering Co.
Supreme Elec. Prods.
Tagliabue Mfg. Co.
White-Rodgers Elec. Co.

VALVES, Hydraulically Operated
Arca Regulators, Inc.
Askania Regulator
Atlas Valve Co.
Auto. Temp. Control
Bailey Meter
Barber-Coleman Co.
Cash Co.
Controls, Inc.
Defender Automatic Reg.
Fisher Governor
Foster Engg. Co.
Gen. Electric Co.
Hays Corp.
Hydraulic Controls, Inc.
Jenkins Bros.
Kiely & Mueller
Leslie Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
Merco Nordstrom Valve
Powers Regulator Co.
Republic Flow Meter
Ruggles-Klingemann
Schade Valve Mfg. Co.
Spence Engineering Co.
Sterling Eng. Co.

VALVES, Lubricated Plug
Merco Nordstrom Valve

VALVES, Motor Operated (See Valves, Diaphragm; Valves, Electrically-operated; Valves, Hydraulically - operated; Valves, Solenoid)

VALVES, Pressure Relief, Reducing, etc.
Abercrombie Pump Co.
American Meter Co.
Ashton Valve Co.
Atlas Valve Co.
Bailey Meter Co.
Bastian-Blessing Co.
Belfield Co.
Boylston Co.
Brown Instr. Co.
Cash Co.
Cochrane Corp.
Connelly Iron Sponge
Crosby Steam Gage Co.
Davis Reg. Co.
D'Este Co.
Fisher Governor Co.
Foster Engg. Co.
Foxboro Co.
Fulton Sylphon Co.
Hagan Corp.
Hanlon-Waters, Inc.
Hoke, Inc.
Illinois Eng. Co.
Kenyon Instrument Co.
Kiely & Mueller
Klipfel Mfg. Co.
Lammert & Mann Co.
Leslie Co.
Manning, Maxwell & Moore
Marsh Corp., Jas. P.
Mason-Neilan Regulator
McAlear Mfg. Co.
Minneapolis-Honeywell
Natural Gas Equipment
Northern Equipment
Powers Regulator Co.
Republic Flow Meters
Ruggles-Klingemann
Schade Valve Mfg. Co.
Seely Instrument Co.
Spence Engineering Co.
Spencer Thermostat Co.
Star Brass Mfg. Co.
Tagliabue Mfg. Co.
Taylor Instr. Cos.
Vapor Recovery Systems
Vaughn-G. E. Witt Co.
Victor Equipment Co.
Watts Regulator Co.
Wilgus Manufacturing

VALVES, Proportional Air-Gas
American Meter Co.
Bristol Co.
Brown Inst. Co.
Cash Co.
Connelly Iron Sponge
Fisher Governor Co.
Hanlon-Waters, Inc.
Lammert & Mann Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
Tagliabue Mfg. Co.

VALVES, Regulating
Am. Gas Furnace Co.
American Meter Co.
Arco Regulators, Inc.
Atlas Valve Co.
Automatic Valve Control
Bailey Meter Co.
Barber Coleman
Bastian-Blessing Co.
Belfield Co.
Boylston Co.
Boiler Room Equipment
Bristol Co.
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Cash Co.
Cochrane Corp.
Connelly Iron Sponge
Davis Reg. Co.
Defender Automatic Reg.
D'Este Co.
Electromatic Corp.
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Foster Engg. Co.
Foxboro Co.
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Fulton Syphon Co.
General Controls Co.
Hagan Corp.
Hanlon-Waters, Inc.
Hannifin Mfg. Co.
Illinois Eng. Co.
Jenkins Bros.
Kiely & Mueller
Klipfel Mfg. Co.
Lammert & Mann Co.
Leslie Co.
Manning, Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg. Co.
Merco Nordstrom Valve
Minneapolis-Honeywell
National Airoil Burner
Natural Gas Equipment
Northern Equipment Co.
Partlow Co.
Parr Inst. Co.
Powers Regulator Co.
Republic Flow Meters
Robertshaw Thermostat
Ruggles-Klingemann
Schade Valve Mfg. Co.
Spence Engineering Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Vaughn-G. E. Witt
Victor Equipment Co.
Wilgus Manufacturing

VALVES, Safety Fuel Shut-off
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Askania Regulator Co.
Atlas Valve Co.
Automatic Products Co.
Automatic Switch Co.
Bristol Co.
Brown Inst. Co.
Cash Co.
Davis Reg. Co.
D'Este Co.
Eclipse Fuel Engg. Co.
Fisher Governor
Friez & Sons
Fulton Syphon Co.
General Combustion Corp.
General Controls Co.
Hanlon-Waters, Inc.
Manning, Maxwell & Moore
Mason-Neilan Regulator
McAlear Mfg. Co.
McDonnell & Miller
Milwaukee Gas Specialty
Minneapolis-Honeywell
National Airoil Burner
Natural Gas Equipment
Partlow Corp.
Payne Furnace & Supply
Penn Electric Switch
Preferred Utilities Mfg.
Ruggles-Klingemann
Spence Engineering Co.
Spencer Thermostat Co.
Tagliabue Mfg. Co.
Viking Instrument Co.
Wilgus Manufacturing

VALVES, Solenoid
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Atlas Valve Co.
Automatic Products Co.
Automatic Switch Co.
Barber-Coleman Co.
Brown Inst. Co.
Cutler-Hammer, Inc.
Davis Reg. Co.
Electric Valve Mfg. Co.
Electrimatic Corp.
Foxboro Co.
Frick Co.
Friez & Sons
General Controls Co.
Gen. Elec. Co.
General Sales & Prod.
Guardian Elec. Mfg.
Hannifin Mfg. Co.
Hays Corp.
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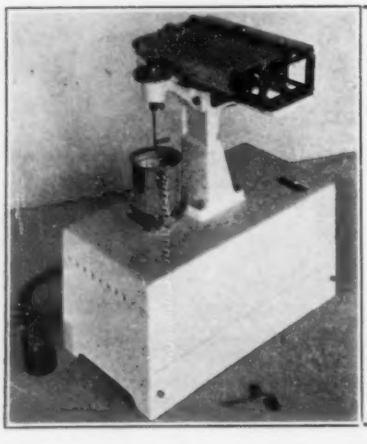

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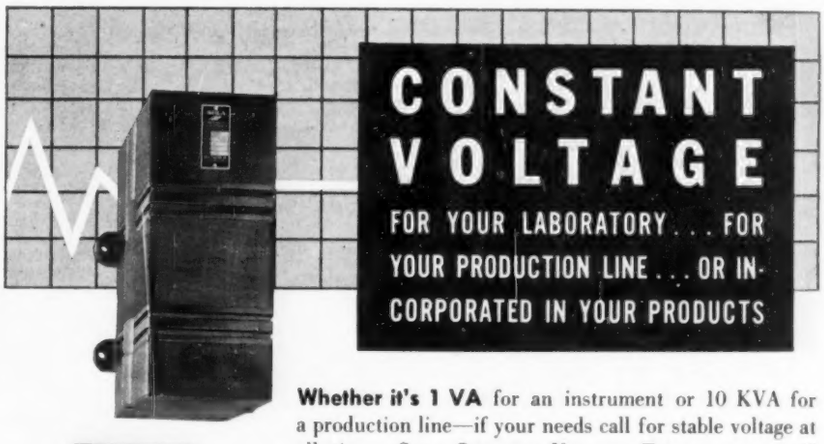

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Whether it's 1 VA for an instrument or 10 KVA for a production line—if your needs call for stable voltage at all times, SOLA CONSTANT VOLTAGE TRANSFORMERS will deliver for you.

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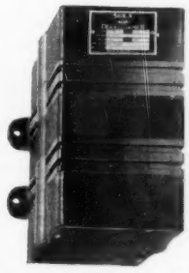

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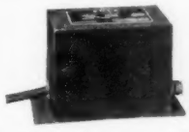

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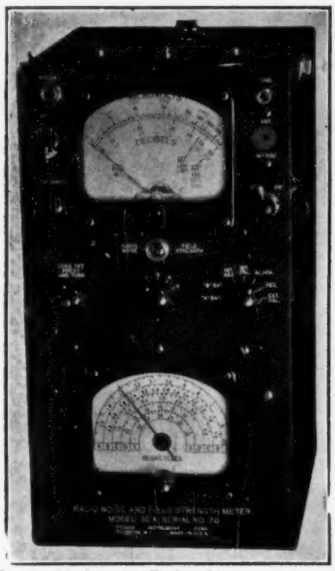

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BOOKS

OF INTEREST TO INSTRUMENT MEN

Applications of Chemical Engineering. Edited by HARRY MCCORMACK. D. Van Nostrand Co., Inc., New York, 1940. Cloth, 6 × 9¼ inches, x + 431 pages. Price $3.75.

For several years it has been known to an increasingly wide circle that (1) the twenty or thirty outstanding instrument engineers in this country who do not hold the degree of Chemical Engineer could qualify as chemical engineers by reason of their years of work with and for the chemical industries: (2) the modern chemical engineer has to be acquainted with at least the fundamentals of Instrumentation.

It is with satisfaction, therefore, that we hail the appearance of a chemical engineering book in which measurement-and-control subjects are properly emphasized. In all probability this emphasis was not deliberate in the sense of having been planned from the start. This book had its inception at the American Institute of Chemical Engineers conference on chemical engineering education in 1929 and 1935, and more particularly at the 1936 meeting of the S.P.E.E. whose Division of Chemical Engineering then appointed an editorial board and a committee on chemical engineering laboratory instructions. No doubt, when these professors of chemical engineering put their heads together they did not even have to discuss the inclusion of measurement and control subjects: they took for granted the importance of these subjects. The result is that the first two chapters are:—

Measurement of Temperature by R. A. Ragatz.

Flow of Fluids by J. H. Rushton.

If that is not giving the place of honor to Instrumentation, what more could one want?

Well, one might want profuse notes on measurement methods in all of the other chapters and in the seventy-two Experiments. And that is exactly what one gets!

The other chapters are as follows:

III. Flow of Heat. By Harry McCormack.

IV. Evaporation and Evaporators. By W. L. Faith and H. McCormack.

V. Distillation. By Joseph H. Koffolt and James R. Withrow.

VI. The Drying of Solids. By O. A. Hougen.

VII. Humidification and Dehumidification. By O. A. Hougen.

VIII. Gas Absorption. By J. C. Elgin and J. C. Whitwell.

IX. Filtration. By E. W. Comings.

X. Classification and Concentration of Solids. By Henry T. Ward.

XI. Size Reduction. By Lincoln T. Work.

All authors are professors of Chemical Engineering. They evidently became well acquainted with one another and evidently worked under extraordinarily competent leadership; and the evidence is the uniformity *cum* diversity which makes this volume a book rather than a heterogeneous collection.

—M. F. BEHAR

The Modern Theory of Solids. By FREDERICK SEITZ. McGraw-Hill Book Co. New York, 1940. Cloth, 6 × 9 inches, xv + 698 pages. Price $7.00.

Not many years ago, most applied scientists regarded the development of quantum mechanics as something unlikely to affect their work. Professor Seitz's book shows, however, that there are a number of technically important properties of solids where quantum theory is already now in a position to contribute to our understanding. Among them are thermal and electrical conductivity, magnetic properties and, to a certain extent, even the mechanical properties like strength and elasticity.

The book begins with the empirical classification of solids into five fundamental types: Metals, ionic crystals, valence crystals, semi-conductors, and molecular crystals. The subsequent chapters deal with the common and different properties of these types, and with the methods of their theoretical treatment. While some sections are highly mathematical, others contain many qualitative arguments and conclusions which will be of great value for engineers, chemists, or experimental physicists, who are not particularly interested in all the mathematical details and who will be greatly assisted by the 306 figures and diagrams. The book is clearly written and it can be heartily recommended.

—I. ESTERMANN, *Assoc. Professor of Physics, Carnegie Institute of Technology, Pittsburgh.*

Standard Handbook for Electrical Engineers—7th Edition. ARCHER E. KNOWLTON, Editor-in-Chief, and R. M. SHOOP, Assistant Editor. McGraw-Hill Book Co., New York, 1941. Leatherette, 6 × 9¼ inches, xii + 2303 pages. Price $8.00.

A handbook is difficult to review as no one individual can take the time to check all the data contained therein. In this case the book is the seventh edition of this well-known electrical engineers' handbook.

Sections on the following subjects are included: Units and Conversion Factors; Electric and Magnetic Circuits; Measurements; Properties of Materials; Circuit Elements; Transformers, Regulators and Reactors; Alternating-current Generators and Motors; Direct-current Generators and Motors; Rectifiers and Converters; Prime Movers; Power Plant Economics; Power System Electrical Equipment; Power Transmission; Power Distribution; Wiring Design—Commercial and Industrial Buildings; Illumination; Industrial Power Applications; Electric Heating and Welding; Electricity in Transportation; Electrochemistry and Electrometallurgy; Batteries; Wire Telephony and Telegraphy; Electronics and Electron Tubes; Radio and Carrier Communication; Codes and Standard Practices and Electrophysics.

—RICHARD RIMBACH

The Meteorological Glossary — Third Edition—First American Edition. By the Authority of the Meteorological Committee, Air Ministry, England. Chemical Publishing Co., Inc., New York, 1940. Cloth, 5½ × 8¾ inches, 251 pages. Price $3.

An alphabetical arrangement of all the terms and concepts met with in meteorology, explaining them. Illustrations show weather-maps of various weather conditions and the various classifications of cloud formations. A large section is devoted to the equivalents of English terms in Danish, Dutch, French, German, Italian, Norwegian, Portuguese, Spanish and Swedish.

—RICHARD RIMBACH

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Industrial Instruments for Measurement and Control. By THOMAS J. RHODES. McGraw-Hill Book Co., Inc., New York, 1941. Cloth, 6 × 9 inches, ix + 573 pages. Price $6.00.

This is one of the fifteen books constituting the McGraw-Hill Chemical Engineering Series. It is a compilation from many and varied sources. As to the discrimination used by the compiler in selecting these sources, opinions will differ. Today the annual output of the instrument manufacturers' literature runs into thousands of different books, catalogs, pamphlets and leaflets. This book includes some very good selections such as those abstracted from Bureau of Standards bulletins, from Behar's books, from ASME publications, from articles in *Instruments* and from others.

At a time like this when industrial instrumentation has become more important than ever before and thousands of men are asked to acquaint themselves with the principles of the operation of these instruments for the purpose of using them efficiently and economically for controlling processes, the need of a book of this type is very great and the author and the publishers are to be commended for rushing ahead with the work and expenditure to do a lot of good, even though all through the book there are scattered errors, omissions, a lack of a uniform terminology, and faulty conceptions that will make a revision rather urgent in the near future. It is particularly important to rectify misquoted equations, errors in spelling, and statements about instruments and their functions which are misleading.

On the other hand, the present scarcity of books suitable for use as a text makes it desirable to have these corrections printed immediately in a current journal such as *Instruments*, which is undoubtedly available to most of the purchasers of this book so that these corrections could be entered in the books by the individuals who are sufficiently interested. I would, therefore, suggest that such corrections be compiled by those in a position to do so as a very practical means of serving the nation in a time of need.

—JOHN J. GREBE, *Director of Physical Research Laboratory, Dow Chemical Co., Midland, Mich.*

Principles of Magnaflux Inspection. By F. B. DOANE. Photopress, Inc., Chicago, 1940. Cloth, 5½ × 8½ inches, 133 pages. Price $2.50.

The proprietary "Magnaflux" method of detecting defects in metals has enjoyed a degree of commercial success without parallel in this field; it has been widely adopted and has contributed much to the inspecting art and to the improvement of the quality of metallic materials. Although the method is well known, it is fortunate now to have a book fully descriptive of the method written by an authority.

The book is organized as follows: Chapter I, Introduction—quality, defects; Chapter II, Magnetism—elements of magnetism, apparatus, the Magnaflux principle; Chapter III, Magnaflux method — principles; Chapter IV, Magnetizing methods; Chapter V, Current characteristics; Chapter VI, The inspection medium—types of powder and of dispersion media, principles in application; Chapter VII, Detectible defects — various types of defects in metals which may be detected; Chapter VIII, Welding—application of Magnaflux in defects in welds; Chapter IX, Demagnetization; Chapter X, Evaluation of indications.

This book should become a standard reference on this subject. It is well written and well printed. For this type of inspecting, it should become the inspector's bible.

—ROBERT F. MEHL, *Head of Metallurgical Dep't, Carnegie Institute of Technology, Pittsburgh.*

Statistical Mechanics. By JOSEPH E. MEYER and MARIA G. MEYER. John Wiley and Sons, Inc., New York, 1940. Cloth, 6 × 9¼ inches, xi + 495 pages. Price $5.50.

Several books on statistical mechanics, a subject neglected for many years, have appeared recently. Among them, this book fills a definite need for a fairly elementary text that treats both theory and applications in a clear and simple manner. Statistical mechanics is a field of theoretical physics, whose applications are of particular interest for chemists and physical chemists; thus a book like the present one, whose authors are a chemist and a theoretical physicist, represents this character very well. The subject is treated on a thoroughly modern basis, i.e., including the principles of quantum mechanics. While intended primarily as a textbook, it contains a number of tables of thermodynamic functions and a detailed index, which make it valuable also as a reference book.

—I. ESTERMANN, *Assoc. Professor of Physics, Carnegie Institute of Technology, Pittsburgh.*

Electrical Measurements and Measuring Instruments. Third Edition. By E. W. GOLDING. Sir Isaac Pitman & Sons, Ltd., London; Pitman Publishing Corp., New York; 1940. Cloth, 5¾ × 8¾ inches, xii + 828 pages. Price $7.50.

In the five years which intervened since the second edition came out in 1935, even since that second edition was reprinted in 1938, there have been advances in the field of electrical measurements and in the design of certain classes of instruments—particularly those used in communications laboratories. Dr. Golding has duly inserted a number of passages and has also made a few corrections. It would have been too much to expect, of course, that this work of nearly a thousand pages, which has become a classic in England, should have been re-written in its entirety or even in large part.

In point of fact, most important changes and additions have to do with "new methods of magnetic testing, of current-transformer testing, and the requirements of the Electricity Supply (Meters) Act of 1936. This last has brought about considerable changes in the methods of meter testing. Many smaller additions have also been made, and further examples, taken from recent examination papers, have been included. While it is impossible to include descriptions of all the many new instruments introduced, the most important of these have been dealt with and references to others have been added in the bibliographies at the ends of the chapters." (Quoted from the Preface to the Third Edition.)

Since "Golding" is already a familiar reference in most American electrical libraries, and since previous editions have been reviewed in *Instruments*, this is not so much a review as a "notice" for the benefit of all readers whose work lies in the field of important electrical measurements.

It may be said for the benefit of those who have never heard of this famous book, that it was primarily conceived and written as "a textbook covering the syllabuses of the B.Sc. Engineering, City and Guilds (final), and I.E.E. examinations in this subject." As usual, there are many pages of examination questions (in this edition, 22 pages) at the back of the book. As usual, most of these are helpful to Americans who are preparing for important Civil Service electrical jobs. As usual, the emphasis is on English design and construction, but the fundamental theory of any type of instrument knows no international boundaries and Dr. Golding is unexcelled in the art of teaching through the medium of words and diagrams on the printed page. The thoroughness of the treatment could be illustrated by many examples but it will suffice to mention that Chapter X on "Illumination," though only 23 pages long, is a veritable little textbook on that subject.

All of the diagrams are reproduced in adequate size, so that no reader will have to use a magnifying glass to make out the lettering, as is so often the case. On the other hand, I cannot understand the necessity for so many full-page illustrations of relatively unimportant details—in fact, not only full-page illustrations but folded inserts showing structural details or outside views of instruments and meters. Another minor flaw is the omission of the dates of the books listed in the bibliographies at the ends of the chapters.

—M. F. BEHAR

British Standard Specification for Dial Gages for Linear Measurements (Excluding Back Plunger Type). British Standards Institution, Publications Dep't, 28 Victoria St., London, 1940. Paper, 5½ × 8½ inches, 20 pages. Price 2 shillings net.

In addition to giving standard specifications for dial gages, this publication contains appendices concerning their recommended dimensions, methods for testing them; and notes on their use and care.

The specifications will interest American readers but they are somewhat unnecessary in this country because of the standardization which has taken place in these instruments by the reliable companies during the past ten years. One interesting specification is a group of five tables included in the main specification which define the permissible errors in a dial indicator. It is interesting to note that a dial indicator having 50 divisions on its face of 0.001" each (an indicator which would fit the specifications of 75% of the dial indicators in any machine shop) may be in error a quarter of a thousandth in five thousandths.

Appendix B, covering notes on methods of testing dial gages, is not only complete but is extremely clear in its presentation both as to method and interpretation of results obtained. It shows the procedure followed in establishing a calibration curve of a dial gage over its entire range.

The most important feature of the publication is its indirect appeal for use of the dial indicator as a comparator and not as a measuring instrument. The calibration curve shown in Appendix B is an excellent argument for using a dial indicator only over short range and for comparison and not measurement.

—RUSH A. BOWMAN, *First Lieut., O.D., U.S.A., Assistant in Charge of Gage Laboratory, Pittsburgh Ordnance District.*

Reports on Progress in Physics, Volume VII (1940). Edited by J. H. AWBERY. The Physical Society, London, SW7, England, 1941. Cloth, 7¼ × 10 inches, 362 pages. Price $4.75.

"No physical research laboratory is completely equipped if it lacks this volume and its precursors" is the assertion which this reviewer has made at the end of his reviews of Vols. III, IV, V and VI of these annual *Reports*. I purposely put this sentence at the start of my review this year, because it is no longer an assertion of opinion but a statement of fact.

For the first time, there is no Preface. Reasons for this omission are not disclosed in the terse one-sheet Publisher's announcement that came with this volume. One reason may be that the usefulness and quality of these *Reports* have won such wide recognition that there no longer is any need for any persuasion or even for any explanation.

And yet a brief Preface could have been written if only to call attention to one new feature which will no doubt be overlooked

by other American reviewers. This new feature consists in printing between parentheses the year of publication of every book, paper or other disclosure to which reference is made in the text. Thus, instead of the nearly-universal custom of citing in this way—

"It had been shown by Jones[25] and by Smith[53] . . ."

the new style is like this—

"It had been shown by Jones (1933) and by Smith (1939) . . ."

and of course the bibliographies at the ends of articles, or of sections of articles, are arranged alphabetically by authors and chronologically for each author. Some bibliographies, moreover, are classified by subjects. Being an editor myself, I could write a long review about this and other evidences of the Editor's painstaking (and successful) efforts to make the whole book easy to use as a reference as well as delightful to read.

Another thing a Preface could have pointed out is that the Editor, and The Physical Society back of him, overcame war-time difficulties to carry out their plans. For example the article on "Photoelectric spectrophotometry and its use in industry" was to have been written by Professor A. C. Hardy of M.I.T. but he could not do it in the time left after he received the Society's invitation, so Dr. W. D. Wright of Imperial S.&T. came up as pinch-hitter and made a home run. (In cricket lingo, "went to the wicket as substitute batsman and scored a century.")

Most of the other articles, of course, do not show signs of having been written under pressure. On the contrary, they are polished gems. The authors, of course, are predominantly British but the reader will recognize one Ohio State and two M.I.T. names in the list of articles which follows:

Sound. By E. G. Richardson.

Musical acoustics. By E. G. Richardson.

Photoelectric spectrophotometry and its use in industry. By W. D. Wright.

The infra-red spectra of polyatomic molecules. By Harald H. Nielsen.

The gamma radiations emitted in nuclear processes. By N. Feather.

The Bohr theory of nuclear reactions. By R. Peierls.

Electron microscopes of high magnifications. By O. Klemperer.

New lens systems. By H. W. Lee.

The absorption of light in interstellar space. By A. Hunter.

Solar physics. By A. D. Thackeray.

Surface tension. By R. C. Brown.

Equations of state. By James A. Beattie and Walter H. Stockmayer.

Electrical discharges in gases and their applications: Part I. By V. J. Francis and H. G. Jenkins.

Some interactions of gases with metals and crystalline solids. By J. K. Roberts.

Viscosity and the nature of substances of high molecular weight in solution. By F. Eirich.

The development of the teaching of experimental physics in British universities. By Allan Ferguson.

At the time of writing this review (Aug. '41) it is learned that only Vols. I, II and IV are out of print. When you order this one, send for III, V and VI . . . and order VIII in advance! The North Atlantic must and will remain an open lane for the interchange of good books like this between the two halves of our common Civilization.

—M. F. Behar

The Electron Microscope (Elektronen-Übermikroskopie). By Manfred von Ardenne. Julius Springer, Berlin, 1940. Paper, 6¾ × 10 inches, 393 pages. Price 54 RM.

This new instrument, the electron microscope, has attracted a great deal of interest in the last few years. It has afforded a new degree of resolution in microscopy, yielding magnifications which at 100,000 diameters are equally good in resolution as those made with the ordinary microscope at 2500 diameters, and permitting the observer to separate distances in the neighborhood of 20 to 50 atom diameters. This new microscope has already opened new fields of research, especially in medicine and bacteriology, and has recently been successfully applied in metallography; its early development was chiefly German, while the American development was made by Dr. Zworykin and his associates at R.C.A. This latter microscope is now on the market and is being widely applied.

The present volume, written by a German authority, is the most complete treatment of the subject the reviewer has seen. It is well-balanced between theory and application. Twenty-seven pages are devoted to the physical basis, six to the theory of the electron microscope, 105 to its construction, and 190 to its operation, including a section on stereoscopy. Numerous excellent electron-microscope photomicrographs are included. The book is well printed, and the diagrams good. This is a book to be unhesitatingly recommended to workers in this field, whether they be interested primarily in the physics of the electron microscope or in its applications.

—Robert F. Mehl, *Head of Metallurgical Dep't, Carnegie Institute of Technology, Pittsburgh.*

Exploration Geophysics. By J. J. Jakosky. Times Mirror Press, Los Angeles, Calif., 1940. Cloth, 6¼ × 9¼ inches, xii + 786 pages. Price $8.

As its name implies, geophysics combines the sciences of physics and geology by employing physical principles for the solution of geological problems. While its most extensive application has been in the search for oil or oil-burning structures in sub-surface rock strata, it has been widely used in mining exploration for metallic minerals and to a minor extent in various other branches of engineering.

Until recently no book on applied geophysics has been available which could, in any sense, be considered comprehensive, although a great deal of literature consisting of individual papers on specialized topics has been published. During the past year this deficiency has been remedied by the almost simultaneous appearance of three new books, one of which is Dr. Jakosky's. The author is well qualified by experience during the period of development of geophysics, as well as by numerous contributions thereto, to write such a treatise. The book covers the entire field of geophysical prospecting for oil and other minerals as well as applications in engineering.

The first two chapters are introductory in nature, giving a brief history of the development of the chief geophysical methods, a discussion of their economic and geologic importance, and an appraisal of their relative usefulness in the fields of exploration in which they are individually applicable. The ensuing chapters are devoted to detailed expositions of the various techniques and procedures used in practice.

The third and fourth chapters deal with the magnetic and gravitational methods which involve surface measurements of variations in the natural magnetic and gravitational fields of the earth with the object of locating anomalous variations in these fields which are diagnostic for the underlying geologic anomalies being sought. Descriptions of the numerous types of instruments, the principles of their operation, and the field procedures by which they are employed, are given. The technique of interpreting the data (deriving the location and nature of the buried features) is also described.

Electrical methods of prospecting are included in the next two chapters. Artificial electromagnetic fields are applied to the region under investigation either by direct application of electric current to the ground or induction therein of an electromagnetic field. If buried ore bodies, water sands, prominent structural relief in certain rock strata, etc., are present they give rise to anomalies in the resultant electromagnetic field which may be detected by sensitive measuring instruments located on the surface. Techniques for interpreting the data are presented. This is the particular type of exploration to which the author has contributed most and is, consequently, the one treated most completely. Electrical methods have found their widest application in the location of metallic ores.

There follows a chapter on seismic methods (used chiefly in prospecting for oil bearing sub-surface rock structures). Sound waves generated at the surface of the ground by means of an explosive charge are reflected and refracted at the interfaces separating strata of different physical characteristics. The data obtained by sensitive portable seismometers permit the calculation of the depth and attitude of the beds from which the recorded impulses were reflected or refracted. In this manner sub-surface strata to depths of 15,000 feet or more can oftentimes be mapped. This chapter is especially noteworthy because of the excellent treatment of methods used in the mapping of beds with steep dips.

A short chapter on geochemical methods involving the chemical analysis of soil samples taken from near the surface as well as rock samples from deep bore holes covers this relatively new technique in a general way. Geothermal methods which make use of temperature measurements and heat flow in the earth are treated in a similar manner.

Two chapters are devoted to the explanation of practically every conceivable method of making physical measurements or taking rock samples in deep drilled wells for the purpose of obtaining information of prospecting value or pertaining to the production of oil in the well.

A final chapter presents practical and legal aspects of permit, trespass and insurance practices relative especially to the personnel and mobile equipment of the field parties conducting geophysical operations.

This book is remarkably complete in embracing every accepted method of geophysical prospecting. Particular emphasis has been placed on field procedures, many useful formulae are derived, and numerous examples of actual survey data are presented. A liberal bibliography of published papers is included in the text, and at the end of each chapter is appended what appears to be a complete list of United States and foreign patents. These tabulated patent references constitute a unique feature of this book. Of especial interest to readers of *Instruments* is the lucid manner in which the large variety of instruments and their principles of operation are described.

However, the fundamental physical principles underlying the various methods have been passed over rather cursorily so that an inquisitive student studying geophysics for the first time would hardly acquire a thorough insight into the theories involved without considerable outside study. Though the contents are highly technical they are not essentially mathematical. Nevertheless, occasional flights are conducted into the realm of high-powered mathematics and physics, as for instance in the treatment of the theory of the torsion balance used in gravity prospecting, and the theory of seismometers used in seismic prospecting. These expositions will go over the heads of those who are not well versed in mathematics and physics, and they appear somewhat incongruous in relation to the rest of the book. In a few instances the order of presentation of related topics is somewhat arbitrary. As a consequence the book is rendered less suitable as a text-book.

Nevertheless, in spite of these minor criticisms, the book is exceptionally well written and readable, and because of the completeness with which it covers the field, it is highly recommended as a reference work. As such, it should be invaluable to anyone interested in geophysics whether his position be administrative, practicing geophysicist, or student.

—C. A. Swartz, *Geophysical Staff, Gulf Research & Development Co., Harmarville, Pa.*

Handbook of English in Engineering Usage — 2nd Edition. By A. C. HOWELL. John Wiley & Sons, Inc., New York, 1940. Cloth, 5 × 7½ inches, ix + 433 pages. Price $2.50.

"It is an affectation and unidiomatic to say *an hotel, an utility company, an historian.*"—From the section on Idiom.

"Wrong	"Right
He compared electricity with water.	He compared electricity to water.
He compared steel to cast iron."	He compared steel with cast iron."

—From the same section on Idiom which, though only four pages long, contains forty-seven other examples as well as eight explanatory paragraphs.

Parallel columns are not always headed "Wrong" and "Right": the reader will find such refreshing variants as "Childish" and "Better."

This brief sampling conveys a clearer idea of this book's character and usefulness than would the usual pedantic review of the usual correct-English reference work. The author is Professor of English in the University of North Carolina—a garden where several flowers of true American culture have recently blossomed because their roots are watered with the elixir of Liberalism. He has produced a guide worth many times its cost to any engineer who wishes to advance more rapidly than the "average" engineer.

In its arrangement and essentials, this guide is well-nigh perfect. It begins with a chapter on the Characteristics of Engineering Writing; then leads the student through The Word, The Sentence and The Paragraph to The Whole Composition. Then—and then only—after these rich chapters, does the author take up somewhat more arid specific subjects:

VI. Punctuation and Mechanics
VII. Grammar
VIII. The Business Letter
IX. Reports
X. Technical Magazine Articles.

It is unlikely that anyone who for decades has earned a part of his income by editing and technical writing will agree with all of Dr. Howell's rules and precepts. One little thing that irks me is Dr. Howell's frequent harping on impersonality, which (to quote Sir William Gilbert) "amounts to a disease." But this criticism applies only to the rules and assertions in his text-matter—not to his choice of examples. One of these examples, a book review (written by Dr. George A. Stetson, Editor of *Mechanical Engineering*, though printed with only the initials "G.A.S.") is far from being impersonal; it even contains such expressions as "one might wish" and "one wonders." For that matter, THE example of examples—the letter from C. F. Kettering to Dr. Howell which is reproduced in facsimile as the frontispiece—opens with:

"In answer [etc.] I should like to make a few remarks regarding the importance of English . . ."

which Dr. Howell himself no doubt considers better than:

"In answer [etc.] a few remarks . . . are submitted."

By the way, I often get in my mail letters with just that style of impersonal opening paragraph, mostly from engineers — engineers who perhaps go to great pains to avoid using the perpendicular pronoun when writing to a veteran editor. Some of them—thank goodness—relax as they go on dictating or writing. Which is all to the good! The book under review is a second edition (*Instruments* did not get a review copy of the first edition in 1930) and I for one wish that the third edition will not teach that engineering English must be so darn austerely impersonal.

Since most readers of this review read newspapers which run daily "Correct English" columns, I have to point out that there is no comparison between Dr. Howell's sound rules and the outmoded rules laid down in these cheap, priggish, often-stupid columns. Dr. Howell recognizes that the English language is continually evolving; the hacks who grind out most of the newspaper "Good English" columns seem to use Victorian-era texts as their sources.

It is impossible, of course, for any man to sense all changes; it is difficult to perceive most of them; it is particularly difficult for a professor whose advantageous closeness to the student body constitutes also the double handicap of hearing only one student body and of being out of touch with other *milieus* where tomorrow's English is being spawned today. In the List of Words Frequently Misused, I find (page 51): "Line. Business vulgarism for *kind of business* or *material*. To be avoided." This was true when "line" meant what is commonly (and vulgarly) called "the complete line." But the relative paucity of collective nouns and the need of avoiding the use of *class, type*, etc., which had acquired specific meanings, gradually endowed *line* with respectability. Since the nineteen-twenties it has been correct to say or to write, for example, "The XYZ Company has added a series of three portable models to its line of recording wattmeters."

In the same list there are two or three other injunctions which are losing their validity but which should be heeded in writing formal technical reports.

But this List of Words Frequently Misused is five pages long; and it alone is worth the price of the book.

—M. F. BEHAR

Fluorescent Light and Its Applications. By H. C. DAKE and JACK DE MENT. Chemical Publishing Co., Inc., Brooklyn, N. Y., 1941. Cloth, 6 × 9¼ inches, xiii + 256 pages. Price $3.00.

To an engineer, this book is extremely interesting. In fact, some portions are fascinating. But it is a reviewers' duty to explain that the attractiveness arises from novelty rather than from practical utility. The authors are respectively Editor and Associate-editor of *The Mineralogist Magazine*. Mr. Dake is the honorary president of the Northwest Federation of Mineral Societies and Mr. DeMent is the research director of the Mineralogist Laboratory. Therefore, their viewpoint is not exactly that of an engineer working in an industrial plant.

Having scrupulously explained this for the benefit of industrial readers who might expect a profusion of application diagrams, tables of exposure for various food-industry or other processing applications, etc., I must add that every worker who makes use of fluorescent light or who expects to do so will find a wealth of fundamental information in this book.

For one thing, the authors have appended a twenty-page bibliography classified under the following headings: Early Work, Radiation, Types of Luminescence, Theory of Luminescence, Activators, Examination Procedure and Technique, Sources, Specific Minerals, Radioactive Minerals, Gems, Collections, General Uses and Applications.

This last heading takes up five pages and is itself divided into the following sub-heads: Microchemistry, Pharmaceuticals, Chemistry, Foods and Food Products, Criminology, Sterilization, Textiles and Dye-stuffs, Medicine and Biology, Petroleum.

The book is divided into eleven chapters, the titles of which correspond closely to those of the extensive bibliography listed above. It concludes with an author index and a subject index.

It is unfortunate that poor proofreading (or some other reason) resulted in awkward typographic and other errors, particularly in the passages which deal with physics rather than with mineralogy. For example on page 12 the table is all mixed up and the attribution of the definition of wavelength to one particular worker is nonsense. But one must not be too critical with a first book—particularly with such an otherwise first-class job.

—M. F. BEHAR

Meteorological Instruments. By W. E. KNOWLES MIDDLETON. University of Toronto Press, Toronto, Canada, 1941. Cloth, 7 × 10 inches, viii + 213 pages. Price $3.25.

This book fills a real need for a treatise on meteorological instruments in English although purposely not as exhaustive in character as Kleinschmidt's handbook (*Instruments*, Vol. 9, 1936, page 188). On the whole it is a comprehensive and well-balanced survey of present-day meteorological instruments with Canadian meteorological instruments naturally featured in view of the author's affiliation with the Canadian Meteorological Service. When there is a choice there is a tie-in with British rather than United States nomenclature and practice which is a little unexpected in spots. The reviewer must hasten to say that developments in this country have not been neglected but the emphasis is secondary in most instances.

The book opens with an introductory chapter which is refreshing in style and in which the author discusses the properties common to meteorological instruments and outlines primary requirements from both the viewpoint of the designer and the user. The other chapters in order are on the measurement of atmospheric pressure (36 pages), temperature (33 pages), humidity (16 pages), precipitation and evaporation (14 pages), wind (38 pages), instruments for investigating clouds (8 pages), sunshine recorders (6 pages) and instruments for investigation of the upper air (20 pages). There is an index. Adequate references are given to original sources and more complete treatments.

The separation of topics in the chapters by well-placed subheads has been done so well as to deserve special commendation. The nomenclature for a number of instruments is novel and in some cases is to be regretted. The print and paper are excellent; the 160 photographs are well selected and leave little to be desired as to clarity and caption.

The reviewer was surprised at his own ignorance of the curious fact that the Canadians and the British use 980.62 cm/sec² as the standard for the acceleration of gravity (page 12); the international value adopted in 1901, is 980.665 cm/sec². The out-of-step value is given as "the standard for mean-sea level at 45 degrees latitude" which is true, but the international standard is not tied up with a latitude in its definition. The difference is 1:25000, not significant except in precise measurements of pressure in a research laboratory.

A minor oversight (page 28) is the failure to give the value of the cubical coefficient of expansion of mercury as part of the discussion of the temperature errors of mercury barometers. Further, attention should be called to the fact not clearly brought out, that for the Kew barometer the temperature correction (equation 2.22) and gravity correction (equation 2.27) cannot be combined as a product simply of the reading plus a constant and the barometer temperature plus the "fiducial" temperature. Therefore it is of doubtful practical value to do other than consider the gravity correction separately for which convenient tables are available. Otherwise the treatment of the corrections to be applied to barometer is excellent.

The error in Fortin type barometers with small diameter cisterns arising from changes in the meniscus in the cistern as the surface fouls is not touched upon.

While space would not permit exhaustive description of the many designs of aneroid barometers, readers would benefit by a fuller discussion, than the brief mention of the Negretti and Zambra steel diaphragm capsules, of the possibilities of the corrugated diaphragm capsule without an auxiliary spring. This type of pressure capsule of nonferrous metal has been used almost exclusively in this country in aviation altimeters since 1928; it is illustrated in figure 154, but not described. The reviewer disagrees with the statement that for aneroid

barometers "elastic errors are usually unimportant . . . faulty temperature compensation is a much more important defect" (page 45). Elastic errors are difficult to remedy and to eliminate by applying corrections; complete temperature compensation offers no primary difficulty.

An unintentional slip in the section on the correction for emergence of thermometer stem on page 63 is the definition of n which should be "n degrees of the mercury thread out of the medium" instead of "n degrees of the scale."

An occasional description of an instrument suffers because the author omitted stating some fact. For example, in describing the record obtained from the Canadian radio sonde, it is not explicity stated how temperature, pressure and humidity are determined from the chart. It can be easily deduced but its omission makes for more difficult reading. In another example a bimetal thermograph is described and it is noted that the instrument described would be improved if the bimetal were made twice as thick, but the original thickness of the bimetal is not given.

The book contains a wealth of information on meteorological instruments written largely from first-hand experience.

It is an essential document for both meteorologists and meteorological instrument engineers and much can be gleaned also by instrument engineers in other fields. The author's presentation and choice of material is such that reading the book is equivalent to a long visit which might be made to learn about the instrument technique and experience of the Canadian meteorological service. Such a visit would reveal that most of the practices and instruments are similar to those used in this country, of those different, some are better, and some not as good, as our own; and so it is when reading the book.

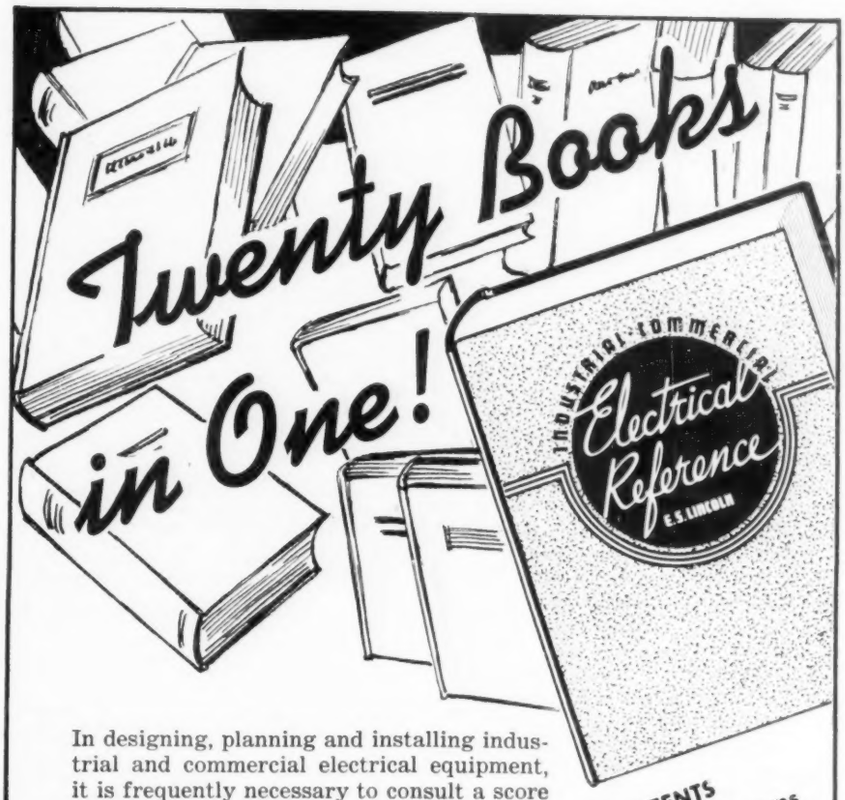
—W. G. BROMBACHER, *Chief, Aeronautic Instruments Sec., National Bureau of Standards, Washington.*

Electron Optics—Theoretical and Practical. By L. M. MYERS. D. Van Nostrand Co., Inc., New York, 1939. Cloth, 5¾ × 9 inches; xviii + 618 pages. Price $12.

In the second line of his Preface the author calls electron optics "an almost new branch of science"; on the second page of his Preface he calls it "this branch of vacuum physics." Inasmuch as electron optics has not yet been "incorporated in the syllabus of any technical school" (excepting the Imperial College of Science and Technology) it is a new science. By the same token this is the first full-length treatise on this new science.

Although the author states that it is written primarily for the graduate student who intends taking up this new science as a career, this book should appeal even more to the present workers in all allied and affected fields, whether they are Sc.D.'s or unencumbered with academic degrees. Research and development men who have been struggling with problems even remotely related to the behavior of "free" electrons will probably find direct leads to solutions and will certainly find fundamental data (many heretofore unpublished) contributing to the rationality and chances of success of proposed approaches to problems. For example, the fifty-four page chapter on "Vacuum Technique" contains many practical suggestions and tables and diagrams covering an astonishingly wide variety of topics, from preparation of cathode surfaces to screen material characteristics, degassing, construction of multipliers, etc. And the 133-page final chapter, entitled "Further Applications," is a rich "catch-all" which seems to be the result of a happy thought on the part of the author, to include *every* bit of useful *recent* miscellaneous information he gathered from his numerous individual and institutional collaborators. (While browsing through this final chapter the reviewer was delighted to find some data on high-temperature phenomena which

(Continued on page 91)



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C

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Cameron Surgical Specialty Co., 666 W. Division St., Chicago, Ill.

Campbell Electric Co., Lynn, Mass.
Transformers, high frequency & X-ray equipment

Campion Labs., Don C., 9088 Alpine Ave., Detroit, Mich.
Liquid meters for small flows

Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Variable & fixed air condensers

Cargille, R. P., 118 Liberty St., New York, N. Y.
Chemical laboratory & photographic devices

Cash Company, A. W., Decatur, Ill.
Combustion control instruments.

Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Scientific instruments & laboratory apparatus

Central Station Steam Co., 2910 E. Woodbridge St., Detroit, Mich.
Rotary type condensate meter

Certified Gauge & Inst. Co., 34-18 Northern Blvd., Long Island City, N. Y.
Pressure gages

Chace Co., W. M., 1600 Beard Ave., Detroit, Mich.
Thermostatic bimetals

Chaslyn Co., 4527 Ravenswood Ave., Chicago, Ill.
Storage battery testers

Chatillon & Sons, John, 85 Cliff St., New York, N. Y.
Iso-elastic springs

Chelsea Clock Company, 284 Everett Ave., Chelsea, Mass.
Clocks & clock movements

Chemical Rubber Co., 1933 West 114th St., Cleveland, Ohio
Laboratory supplies

Chicago Apparatus Co., 1735 No. Ashland Ave., Chicago, Ill.
Laboratory supplies

Chicago Dial Indicator Co., 544 W. Washington, Chicago, Ill.
Machinist's dial indicators

Chicago Surgical & Electrical Co., 324 W. Superior St., Chicago, Ill.

Cincinnati Clock & Instrument Co., 1113 York St., Cincinnati, Ohio
Circuit breaker analyzer

Cincinnati Scientific Co., 224 Main St., Cincinnati, Ohio
Laboratory supplies

Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati, Ohio
Time recorders

Claffin Co., Geo. L., 150 Dorrance St., Providence, R. I.

Clamp Inst. Co., Webster, Mass.
Aircraft instruments, thermometers & pressure & vacuum gages

Clare & Co., C. P., 4719 Sunnyside Ave., Chicago, Ill.
Relays, electric counters & electro mechanical specialties

Clark Blast Meter Co., Chas. J., Gladbrook, Iowa
Foundry blast meters & pressure gages

Clark & Sons Co., Alvan, 58 Day St., West Somerville, Mass.
Optical & astronomical instruments

Clark, Jr. Pneumatic Tool Co., Jas., 143 17 Ave., Paterson, N. J.
Adjustable snap gages

Clarostat Mfg. Co., Inc., 285 North Sixth St., Brooklyn, N. Y.
Resistors

Clay-Adams Co., Inc., 44 E. 23 St., New York, N. Y.
Angle & micro centrifuges, compact balances, analytical weights, microscope slides & cover glasses, glass & porcelain ink, tuning forks

Clebar Watch Co., 551 Fifth Ave., New York, N. Y.
Stop watches, timers & chronographs

Cleveland Gas Meter Co., 2180 East 65th St., Cleveland, Ohio
Tin case gas meters

Clifford Mfg. Co., 584 E. First St., Boston, Mass.
Metallic bellows & diaphragms; thermostatic assemblies; packless valves

Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Electrical instruments, communication testing instruments

Coats Machine Tool Co., Inc., 110 West 40th St., New York, N. Y.
Spring testers

Cochrane Corp., 17th St., Allegheny Avenue, Philadelphia, Pa.
Flowmeters, electrical & mechanical; liquid level meters & controllers; weir meters; pressure & temperature recorders; blow off & relief valves

Cole Co., H., 24 North High St., Columbus, Ohio
Surveying instruments

Coleman Electric Co., Inc., 310 Madison St., Maywood, Ill.
Electrical measuring instruments for technical applications

Colloid Equipment Co., Inc. 50 Church St., New York, N. Y.
Laboratory apparatus

Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland, Ohio
Rheostats, instruments, shunts, switchboards & special electrical equipment

Columbia Metal Box Co., 260 E. 143rd St., New York, N. Y.

Commerce Pattern Foundry & Machine Co., 2211 Grand River Ave., Detroit, Mich.
Balancing machines

Commercial Engineering Labs., 4612 Woodward Ave., Detroit, Mich.
Laboratory instruments for automotive, aircraft, railway & allied industries: air flow indicators, direct pressure & piezo-ray engine indicators, fuel flow indicators, magnetic gages, torsional vibration indicators (piezo-ray), recorders (torsiographs) & recording instruments for car performance & riding comfort

Commercial Iron Works, 2426 Porter St., Los Angeles, Calif.
Orifice fittings

Comtor Company, 87 Rumford Ave., Waltham, Mass.
Precision internal & external comparator-type diameter gages

Conant, George H., 719 Watson St., Ripon, Wis.

Connelly Iron Sponge & Governor Co., 3154 So. California Ave., Chicago, Ill.
Gages & manometers, B T U indicator & H_2S tester

Consolidated Ashcroft Hancock Co.
See Manning, Maxwell & Moore, Inc.
Consulting & Engineering Co., Carson St. & Terminal Way, Pittsburgh, Pa.
Combustion controllers
Continental Electric Co., Geneva, Ill.
Photoelectric tubes & equipment
Control Corporation, 600 Stinson Boulevard, Minneapolis, Minn.
Automatic & remote control equipment
Controls, Inc., Towaco, N. J.
Control valves; motor driven time delay relays; process timing devices
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Electrical control devices, metal bellows, vapor motors & telephone protective & distributing apparatus
Cook Research Laboratories, L. H., Menlo Park, California
Precision testing instruments for oil industry, oil well cement testing equipment, combustible gas indicators, depth pressure recorders
Coors Porcelain Co., Golden, Colo.
Chemical & scientific porcelain
Corbin Screw Corp., New Britain, Conn.
Tachometers & speedometers
Cornell-Dubilier Electric Corp., So. Plainfield, New Jersey
Mica, dykanol, paper & wet & dry electrolytic capacitors
Corning Glass Works, Corning, N. Y.
Technical glassware
Cramer Co., Inc., R. W., Centerbrook, Conn.
Interval timers, running time meters, time switches, signal control switches
Crosby Steam Gage & Valve Co., 30 Church St., New York, N. Y.
Safety & relief valves, gages, recorders, testers & steam engine indicators
Curtin & Co., W. H., 2019 Franklin Ave., Houston, Tex.
Laboratory supplies
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee, Wis.
Electric motor control, safety switches, motor driven valve operators, gas calorimeters, gas mixing & stabilizing control, **resistors**

D

Daigger & Co., A., 159 W. Kinzie St., Chicago, Ill.
Laboratory supplies
Daniel Orifice Fitting Co., 3350 U. P. Ave., Los Angeles, Calif.
Orifice fittings
Daven Co., 158 Summit St., Newark, N. J.
Attenuators, calibrating equipment for electrical instruments & resistors
Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark, N. J.
Inflammable gas alarms
Davis Regulator Co., 2541 So. Washtenaw Ave., Pilsen Sta., Chicago, Ill.
Valves
Dearborn Gage Co., 22038 Beech St., Dearborn, Mich.
Chromium plated gage blocks
Defender Automatic Regulator Co., 308 S. 8th St., St. Louis, Mo.
Industrial instruments
De Jur-Amsco Corp., Shelton, Conn.
Photoelectric exposure meters, electrical, radio & photographic products
Deimhorst, Wm. J., 90 West St., New York, N. Y.
Moisture detectors
Deming Indicator Co., 108 Fountain Ave., Dayton, Ohio
Test indicators
Demuth Glass Works, Inc., Wythe Ave. at N. 11th St., Brooklyn, N. Y.
Denominator Co., Inc., 261 Broadway, New York
Group counting machines
Denver Fire Clay Co., 2301 Blake St., Denver, Colo.
Specialized industrial control equipment for power plant & processing industries, laboratory specialties
D'Este Co., Julien, 69 A Street, So. Boston, Mass.
Control valves
Detecto Scales, Inc. see Jacobs Bros. Co., Inc.
Detroit Air Meter Co., P. O. Box 1473, Detroit, Mich.
Air flowmeters
Detroit Lubricator Co., 5900 Trumbull Ave., Detroit, Mich.
Automatic controls & equipment for air conditioning
Detroit Testing Machine Co., Grinnell Ave., Detroit, Mich.
Testing machines
Deutschmann Corp., Tobe, Canton, Mass.
Equipment for locating, eliminating, and measuring radio noise; electrolytic, paper dielectric & oil type capacitors
Dickson Co., 7420 Woodlawn Ave., Chicago, Ill.
Furnace controls
Dietert Co., Harry W., 9330 Roselawn Ave., Detroit, Mich.
Sand testing equipment; immersion pyrometers, moisture testers, accessories for spectrographic laboratories
Dietzen Co., Eugene, 2425 Sheffield Ave., Chicago.
Drafting & surveying instruments.
Dillon & Co., Inc., W. C., 5410 W. Harrison St., Chicago, Ill.
Traction dynamometers, tensile machines, thermometers
Distillation Products, Inc., 755 Ridge Road West, Rochester, N. Y.
High vacuum pumps, low vapor pressure fluids & auxiliary equipment
Doerr Glass Co., Inc., 500 Peach St., Vineland, N. J.
Dongan Electric Mfg. Co., 2987 Franklin St., Detroit, Mich.
Transformers
Doolittle Radio, Inc., 7421 Loomis Blvd., Chicago, Ill.
Frequency monitor
Dorr-Patterson Engineering Co., 3362 Wight St., Detroit, Mich.
Physical testing machines
Drafto Co., Cochranton, Pa.
Drafting machines
Driftmeter, Inc., 616 Exchange Bank Bldg., Tulsa, Okla.
Oil well instruments
Dubrovin, John, 2946 N. Kenneth Ave., Chicago, Ill.
Mercurial vacuum gage, absolute type
Ducommun Co., M., 580 Fifth Ave., New York, N. Y.
Coil-spring stopwatches
Du Mont Labs., Inc., Allen B., 2 Main Ave., Passaic, N. J.
Cathode-ray oscillographs, cathode-ray tubes, associated electronic equipment, television control, studio & transmitting equipment
Duncan Electric Mfg. Co., Lafayette, Ind.
A-c. & d-c. watthour meters, service & switchboard types; portable test meters, appliance meters & instrument transformers
Dunn, Inc., Struthers, 1310 Cherry St., Philadelphia, Pa.
Relays, timing devices, electric counters, thermostats
Durant Manufacturing Co., 1930 N. Buffum St., Milwaukee, Wisc.
Counting & measuring machines
Dwyer Mfg. Co., F. W., 565 W. Washington Blvd., Chicago, Ill.
Portable & stationary draft gages, CO_2 indicators & combustion testing sets

E

Eagle Signal Corp., 202 20th St., Moline, Ill.
Industrial control devices, traffic signal controllers & sign flashers
Eastern Engineering Co., 45 Fox St., New Haven, Conn.
Laboratory pumps, stirrers & thermoregulators
Eastern Science Supply Co., 7-9 High St., Brookline, Mass.
Meteorological instruments
Eastern Scientific Co., 51 Bassett St., Providence, R. I.
Eastern Specialty Co., 3617 N. 8th St., Philadelphia, Pa.
Testing equipment for checking & maintenance of all types of electricity meters such as watthour meters, demand instruments, etc. Special apparatus for load survey work.
Eberbach & Sons, Ann Arbor, Mich.
Laboratory furniture
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Relays & radio parts
Eclipse Aviation, Div. of Bendix Aviation Corp., Bendix, N. J.
Aircraft electrical & mechanical accessories
Economy Electric Devices Co., 37 West Van Buren St., Chicago, Ill.
Electric meters, watthour & amperehour, for street and electric railways and trolley busses
Edelmann & Co., E., 2332 Logan Blvd., Chicago, Ill.
Automotive test instruments
Edison, Inc., Thomas A., Edison Electrical Controls division, West Orange, N. J.
Sealed-in-glass control devices, including thermostatic switches, fire detection thermostats, & timing relays. Hermetically sealed thermostatic valves. Special control equipment
Eimer & Amend, 635 Greenwich St., New York, N. Y.
Biological & chemical laboratory apparatus & supplies
Eitzen Co., Louis C., 17 W. 60 St., New York, N. Y.
Extensometers
Electric Auto-Lite Co., Chrysler Bldg., New York, N. Y.
Pressure & vacuum gages, speedometers, tachometers & thermometers
Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio
Electrical controllers
Electric Heat Control Apparatus Co., 507 Fifth Ave., New York, N. Y.
Laboratory ovens
Electric Indicator Corp., 21 Parker Ave., Stamford, Conn.
Synchronous motors, position indicators, level controls, signalling devices
Electric Sorting Machine Co., Michigan Trust Bldg., Grand Rapids, Mich.
Color analysers
Electric Speed Indicator Co., 1652 Onondaga, Lakewood, Ohio
Precision electric tachometers & remote position indicators
Electric Switch Corp., 1409 Union St., Columbus, Ind.
Mercury switches
Electric Tachometer Corp., 1358 Spring Garden St., Philadelphia, Pa.
Speed indicators & recorders, electric & mechanical counters
Electric Valve Mfg. Co., 64 Murray, New York, N. Y.
Electrically operated valves
Electrical Coil Winding Co., 2736 Saunders St., Camden, N. J.
Magnet & solenoid coils
Electrical Facilities Inc., 4224 Holden St., Oakland, Calif.
Apparatus for electrical measuring & testing, including precision transformers, watthour meter and instrument transformer testing equipment; rectifier apparatus
Electrical Research Products Inc., 195 Broadway, New York, N. Y.
Instruments are offered for acoustic, noise or vibration control problems, in the product development laboratory, for field testing and for routine production testing applications
Electrical Testing Labs., 80th St. & East End Ave., New York, N. Y.
Electrical testing & inspection
Electrimatic Corp., 2100 Indiana Ave., Chicago, Ill.
Automatic control valves & controls, regulating valves, Pressure, temperature & electrical actuation
Electro-Medical Laboratory, Inc., Holliston, Mass.
Neurological & allied medical instruments & general electronic apparatus
Electro Products Laboratories, 549 West Randolph St., Chicago, Ill.
Battery eliminators & rectified A.C. devices
Electrocon Corp., 6 Varick St., New York, N. Y.
Vibration measuring instruments & equipment for dynamic balancing of rotating machines
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Calif.
Photo-electric instruments; also photoconductive cells.
Electronic Products Co., St. Charles, Ill.
Electronic devices
Electronic Research Laboratory, Niles Center, Illinois
Color analysis apparatus
Electrons, Inc. of Delaware, 127 Sussex Ave., Newark, N. J.
Gas-filled & grid-control rectifier tubes
Elematic Mfg. Co., 12757 S. Western Ave., Blue Island, Ill.
Pyrometers
Elgin National Watch Co., Elgin, Ill.
Watches, clocks, aircraft instruments, navigational instruments
Ellison Draft Gage Co., 214 West Kenzie St., Chicago, Ill.
Manometers, draft gages, orsats
Elsbert Mfg. Co., Inc., 910 W. Lake St., Chicago, Ill.
Remote control fractional horsepower motors
Emerson Apparatus Co., 171 Tremont St., Melrose, Mass.
Calorimeters
Engel, Inc., H. C. M., P. O. Box 233, Sidney, N. Y.
Small drills, small turned parts, millstones in sapphire and block grinding discs
Engelhard, Inc., Charles, 233 New Jersey R. R. Ave., Newark, N. J.
Industrial instruments
Engineering Laboratories, Inc., 705 Kennedy Bldg., Tulsa, Okla.
Seismic exploration equipment, vibration detectors, petroleum engineering devices, signalling equipment
Eppley Laboratory Inc., 12 Sheffield Ave., Newport, R. I.
Thermopiles, pyrheliometers & standard cells for both industrial & laboratory use
Ermastat Co., 1825-39 Wylie St., Philadelphia, Pa.
Electric motor overload protectors
Erwin Co., O. E., 1274 Augusta Blvd., Chicago, Ill.
Ess Instrument Co., George Washington Bridge Plaza, Fort Lee, N. J.
Combustion indicators & recorders, visual & electric eye smoke indicators, flame failure alarms, sensitive relays & special electric eye indicators
Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis, Ind.
Graphic recording & contact-making electrical instruments, time, speed, condensate purity, pressure & vacuum recorders, telemeters & portable current transformers
Etched Products Corp., 39-01 Queens Blvd., Long Island City, N. Y.
Dials, scales & panels
Everson Mfg. Co., 214 W. Huron St., Chicago, Ill.
Chemical feeders
Exact Weight Scale Co., 944 West 5th Ave., Columbus, Ohio
Over-and-under weight scales & indicators for industrial purposes

F

Faichney Instrument Corp., Watertown, N. Y.
Laboratory thermometers

Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago, Ill.
Scales

Falstrom Co., Main Ave. & D. L. & W. R. R., Passaic, N. J.
Steel instrument panels, panel board assemblies, cubicles, totally enclosed weather & vermin proof instrument enclosures & steel cabinets

Farrel-Birmingham Co., Inc., 25 Main St., Ansonia, Conn.
Calipers for checking roll diameters & gear tooth comparators

Fassett Co., Inc., C. M., 209 North Wall St., Spokane, Wash.
Laboratory supplies

Fecker, J. W., 2016 Perrysville Ave., N. S., Pittsburgh, Pa.
Astronomical instruments

Federal Pneumatic Systems, Inc., 127 N. Dearborn St., Chicago, Ill.
Particle size classifiers

Federal Products Corp., 1144 Eddy St., Providence, R. I.
Precision measuring instruments

Federal Telegraph Co., Inc., 200 Mt. Pleasant Ave., Newark, N. J.
Radio transmitting and direction finding equipment, transmitting tubes, field intensity meters, high speed engine indicators

Fee and Stemwedel, Inc., 1954 No. Western Ave., Chicago, Ill.
Dial type thermometers, barometers, humidity indicators & allied products, field glasses & binoculars

Fellows Gear Shaper Co., Springfield, Vt.
Gear checking machines & involute measuring machines

Fenwal, Inc., 3 Main St., Ashland, Mass.
Industrial thermostats

Ferner Co., R. Y., 131 State St., Boston, Mass.
Precision instruments

Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Electrical instruments

Ferris Instrument Corp., Boonton, N. J.
Laboratory & production testing equipment, radio noise & field strength meters & special electrical instruments

Fidelity Machine Co., 3906 Frankfort Ave., Philadelphia, Pa.
Abrasion testers
Vacuum thermocouples

Fink-Roselieve Co., Inc., 109 W. 64th St., New York, N. Y.
Thermometers

Fischer & Porter Co., 37 County Line Road, Hatboro, Pa.
Rotameters, sight flow meters, automatic flow controllers, precision optical cells, precision bore glass tubing, & special precision glass apparatus.

Fish-Schurman Corp., 250 East 43rd St., New York, N. Y.
Scientific instruments, optical, technical & scientific glassware & porcelain

Fisher Governor Co., Marshalltown, Iowa
Motor control valves & regulators

Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Standard & special equipment & instruments for chemical, biological & metallurgical laboratories

Fleischhauer & Son, Frank, 89-36 187 Place, Hollis, L. I., N. Y.
Instrument makers

Fluid Meters, Inc., 44 Wall St., Room 1101, New York, N. Y.
Positive displacement meters, 1/10 to 8 gallons per hour with gravity pressures

Ford Meter Box Co., Wabash, Indiana
Water meter testers

Ford Motor Company, 3674 Schaefer Rd., Dearborn, Mich.
Johansson gage blocks & accessories such as parallels, adjustable holders, scribers, straight edges, center points, sine bars

Ford Regulator Valve Co., 403 Broome St., New York, N. Y.
Regulating valves

Foster Engineering Co., 109 Monroe St., Newark, N. J.
Control valves

Foxboro Co., 46 Neponset Ave., Foxboro, Mass.
Indicating, recording & controlling instruments for pressure, temperature, humidity, level & flow

Fredericks Co., George E., Bethayres, Pa.
Glass instruments & apparatus

Frick Co., Inc., Waynesboro, Pa.
Float valve controls & electric controls, refrigerating & air conditioning machinery

Fried & Lustig, Inc., 31 Union Square, New York, N. Y.
Thermometers

Friez & Sons, Division, Julien P., Bendix Aviation Corp., Baltimore St. & Central Ave., Baltimore, Md.
Temperature & humidity controls, gas & stoker controls, damper motors, electrical relays, temperature & humidity indicators & recorders, psychrometers, draft gages, anemometers, CO_2 analyzers

Fuess, Inc., R., 39 West 60th St., New York, N. Y.
Scientific instruments

Fuller Co., 110 Bridge St., Catasauqua, Pa.
Bulk material level controllers

Fulton Syphon Co., Knoxville, Tenn.
Temperature & pressure regulators, sylphon bellows; thermostat assemblies; diesel controls; automobile thermostats; air conditioning controls

Furnas Electric Co., 811 South 72nd St., West Allis, Wis.
Pressure controls

G

Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
Physical & scientific instruments

Gas Appliance Specialties Co., 57th St., bet. Northern Blvd. & 32nd Ave., Woodside, New York, N. Y.
Gas regulators

Gauthier, Donat A., 7408 Poe Ave., Detroit, Mich.
Gasoline measuring devices & automobile service station testers

Geier & Bluhm Inc., 607 River St., Troy, N. Y.
Mechanical devices & spirit level vials

Genales, Andrew, 29 Second Ave., Nyack, N. Y.
Toolroom test indicators

General Biological Supply House, Inc., 761 East 69th Pl., Chicago, Ill.
Biological laboratory supplies

General Combustion Corp., 2218 W. Lake St., Chicago, Ill.
Combustion equipment

General Controls Co., 1370 Harrison, San Francisco, Calif.
Control valves

General Electric Co., 1 River Rd., Schenectady, N. Y.
Electrical instruments & meters

General Electric Co., Lamp Dept., Nela Park, Cleveland, Ohio
Lighting sources

General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Medical, dental & industrial X-ray apparatus, accessories & suppliers

General Engg. & Model Works, 421 N. Braddock Ave., Pittsburgh, Pa.
Gages & precision measuring instruments for checking threaded tubular products

General Physical Laboratory, 509 Fifth Ave., New York, N. Y.
Special light sources

General Radio Co., 30 State St., Cambridge, Mass.
Radio & electrical measuring instruments for laboratory & industrial use: stroboscopes, noise measuring equipment, measuring & test equipment for electrical communication systems

General Regulator Corp., 165 Broadway, New York, N. Y.
Combustion, draft, liquid level & pressure controls

General Sales & Products Corp., 45 Mohawk St., Cohoes, N. Y.
Shut-off valves

General Scientific Corp., 4829 So. Kedzie Ave., Chicago, Ill.
Lenses & photoelectric cells

General Television Corp., 70 Brookline Ave., Boston, Mass.
Ionization vacuum gages

Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Instruments & accessories for prospecting for oil, minerals, water, bedrock; also equipment for making measurements in wells

Gilmore, E. R., Box 5718, Homewood Sta., Pittsburgh, Pa.
Gas leak stethoscopes

Gilmore Drug Co., W. J., 422 Blvd. of Allies, Pittsburgh, Pa.
Laboratory supplies

Gisholt Machine Co., Madison, Wis.
Static & dynamic balancing machines

Glass Engraving Co., 3604-3606 Park Ave., New York, N. Y.
Glass engraving

Gleason-Avery, Inc., 27 Clark, Auburn, N. Y.
Furnace controls

Globe Phone Mfg. Corp., Reading, Mass.
Pipe locating equipment, leaky valve locators, hearing aids, secret phone or listening equipment for government investigating agencies

Globe Tool & Engg. Co., 410 Davis Ave., Dayton, Ohio
Dynamic balancing equipment

Glogau & Co., 1632 Rand McNally Bldg., Chicago, Ill.
Calipers

G-M Laboratories, Inc., 4326 N. Knox, Chicago, Ill.
Photoelectric cells, photoelectric relays, slide wire rheostats, galvanometers, laboratory stands & clamps

G. M. Manufacturing Co., 248 Lafayette St., New York, N. Y.
Thermometers, hydrometers, psychrometers, hygrometers

Goerz American Optical Co., C. P., 317 East 34th St., New York, N. Y.
Photographic lenses & accessories

Goetze Niemer Co., 808 Francis St., St. Joseph, Mo.

Gogan Machine Corp., 1440 E. 55 St., Cleveland, Ohio
Automatic hardness testers

Goldak Co., 1031 S Broadway, Los Angeles, Calif.
Surveying Instruments.

Goodrich Co., B. F., 450 South Main St., Akron, Ohio
Vibration absorbers

Gordon Co., Claud S., 3000 S. Wallace St., Chicago, Ill.
High temperature equipment accessories, such as thermocouples, thermocouple wire, lead wire, insulators

Gorrell & Gorrell, Chicago Heights, Ill.
Equipment for biological & psychological work

Gotham Instrument Co., 149 Wooster St., New York, N. Y.
Indicating, dial & recording thermometers

Gotham Scientific Co., 106 Water St., New York, N. Y.
Laboratory supplies

Gow-Mac Instrument Co., 22 Lawrence St., Newark, N. J.
Thermal conductivity gas analyzers & gas analysis cells

Gray Instrument Co., 64½ W. Johnson St., Philadelphia, Pa.
Scientific instruments

Green, Henry J., 1191 Bedford Ave., Brooklyn, N. Y.
Meteorological instruments

Greene Bros., Inc., 1810 Griffin St., Dallas, Texas
Laboratory Supplies

Greenfield Tap & Die Corp., Greenfield, Mass.
Machine shop gages

Greiner, Inc., Emil, 55 Vandam St., New York, N. Y.
Laboratory Supplies

Griebel Instrument Co., Inc., 42 River St., Carbondale, Pa.
Thermometers, hydrometers, chemical & laboratory glassware

Griner Co., A. J., 417 East 13th St., Kansas City, Mo.
Laboratory supplies

Grove Regulator Co., 1729 Poplar St., Oakland, Calif.
Pump governors, pressure reducing & back pressure regulators for gas or liquid pressures to 6000 lbs.

Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
A-c. and d-c. relays

Gump Co., B. F., 435 S. Clinton St., Chicago, Ill.
Scales

Gurley, W. & L. E., 514 Fulton St., Troy, N. Y.
Surveying & allied engineering instruments, paper testing & aeronautical navigation instruments & standard weights & measures

H

Hagan Corp., 600 Bowman Bldg., Pittsburgh, Pa.
Combustion control equipment

Haines Gauge Co., 119 South 4th St., Philadelphia, Pa.
Dial micrometer gage

Hankscraft Co., 1007 E. Washington Ave., Madison, Wis.
Timers

Hall-Jorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Laboratory transformers

Halliburton Oil Well Cementing Co., Duncan, Okla.
Oil well surveying instruments

Hamilton Mfg. Co., Two Rivers, Wis.
Laboratory furniture

Hanlon-Waters, Inc., Box 1559, Tulsa, Okla.
Pressure & level controls, time cycle controllers

Hannifin Mfg. Co., 621 So. Kolmer Ave., Chicago, Ill.
Valve operating devices

Hanovia Chemical & Mfg. Co., 90 Chestnut St., Newark, N. J.
Quartz mercury arc lamps

Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
Resistors

Hart Manufacturing Co., 110 Bartholomew Ave., Hartford, Conn.
Thermostats, remote control switches, magnetic relays, heater switches, motor control switches, mercury tube relays

Hart Mfg. Co., R. E., 416 Ward Bldg., Battle Creek, Mich.
Production counters

Hart Moisture Gauges, Inc., 126 Liberty St., New York, N. Y.
Kaydel moisture gages.

Hasler-Tel Co., 30 Vesey St., New York, N. Y.
Speed indicators, portable, chronometric

Hathaway Instrument Co., 1315 S. Clarkson St., Denver, Colo.
Instruments & apparatus for electrical & mechanical measurements & control.

Hausser & Son, C. A., 6040 Belfield Ave., Philadelphia, Pa.

Hayes Scientific Appliances, 202 N. Broadway, Urbana, Ill.
Scientific instruments

Hays Corp., P. O. Box 299, Michigan City, Ind.
Combustion instruments & automatic combustion controls

Hayward, H. N., 612 W. Oregon St., Urbana, Ill.
Tachometer Testers

H-B Electric Co., Inc., 2501 N. Broad St., Philadelphia, Pa.
Mercury tube relays

H-B Instrument Co., Inc., 2501 N. Broad St., Philadelphia, Pa.
Thermometers & hydrometers, remote control equipment

HD Electric Co., 100 W. Monroe St., Chicago, Ill.
Split core ammeters

Hebler Co., W. O., Central at Long Ave., Hillside, N. J.
Electrical gas analyzers

Heil Corporation, 216 S. 4 St., St. Louis, Mo.
Laboratory Supplies

Helland Research Corp., 700 Club Bldg., Denver, Colo.
Geophysical instruments, photoflash synchronizers, gas detectors, oscillographs, strain gages, vibration detectors, recording cameras & industrial instruments

Heise Bourdon Tube Co., 275 Noble Ave., Bridgeport, Conn.
Bourdon tube devices

Hellige, Inc., 3718 Northern Blvd., Long Island City, N. Y.
Scientific instruments, laboratory & bacteriological supplies

Henderson & Co., H. B., East Liverpool, Ohio
Pyrometric cones

Henschel & Co., Inc., John, 105 E. 29th St., New York, N. Y.
Drawing instruments

Henszey Co., Watertown, Wis.
Feed water meters, flow indicators continuous blowdown, heat exchangers and boiler feed regulators. Also meters and flow indicators for corrosive chemicals

Heusser Instrument Mfg. Co., 134 West Second South St., Salt Lake City, Utah
Analytical balances

Hewlett-Packard Co., 481 Page Mill Road, Palo Alto, California.
Electronic equipment

Heyman Co., 157 Chambers St., New York, N. Y.
Inspection Instruments

H & H Thermostats, Inc., 270 Lafayette St., New York, N. Y.

Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Electric indicating instruments

Hoffman Co., S. O., 835 Howard St., San Francisco, Calif.
Bolometers

Hoke, Inc., 585 Eagle Ave., New York, N. Y.
Regulators

Holtzer-Cabot Electric Co., 125 Amory St., Boston, Mass.
Fractional Horsepower Motors

Hoskins Mfg. Co., 4445 Lawton Ave., Detroit, Mich.
Thermo-couples, heating elements, pyrometers & electric furnaces

Houser Engg. & Mfg. Inc., 123 N. Main St., Bluffton, Ind.
Miles per Gallon Meter

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OUR 30 YEARS EXPERIENCE ASSURES BEST QUALITY & PROMPT PERFORMANCE.

NAMEPLATES • PANELS *etc.*

AND ON ANY METAL

PREMIER METAL ETCHING COMPANY

21-03 44TH AVENUE LONG ISLAND CITY, N. Y.

Post Company, Frederick, P. O. Box 803, Chicago, Ill.
Instruments & equipment for architect & engineer

Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Automotive service instruments

Powers Regulator Co., 2734 Greenview Ave., Chicago, Ill.
Controls for air conditioning, temperature & humidity; also water temperature controls, dial indicating & recording thermometers & steam traps

Practical Instrument Co., 2717 N. Ashland Ave., Chicago, Ill.
Recording thermometers & operation recorders

Pratt & Whitney, Div. Niles-Bement-Pond Co., Hartford, Conn.
Machine shop instruments

Precision Apparatus Corp., 647 Kent Ave., Brooklyn, N. Y.
Radio test instruments

Precision Gage & Tool Co., 320 East 3rd St., Dayton, Ohio
Machine shop gages

Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Resistors

Precision Scientific Co., 1736 N. Springfield Ave., Chicago, Ill.
Standard & custom-built laboratory equipment

Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Scientific instruments

Precision Tube Company, 3824-26-28 Terrace St., Philadelphia, Pa.
Fine tubing & metal shielded wire

Preferred Utilities Mfg. Corp., 31 West 60th St., New York, N. Y.
Boiler plant instruments

Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Piezo electric quartz and tourmaline crystals, reactance & capacity meters

Premier Metal Etching, 21-03 44th Ave., Long Island City, N. Y.
Instrument dials & scales; nameplates & panels

Process Controls, Inc., Le Roy, N. Y.
Paper industry controls

Production Instrument Co., 710 W. Jackson Blvd., Chicago, Ill.
Electric & mechanical counting, timing & recording devices & actuating switches

Pyrometer Instrument Co., 103 Lafayette St., New York, N. Y.
Pyrometers for various purposes

R

Racine & Co., Jules, 20 West 47th St., New York, N. Y.
Stop watches

Radio City Products Inc., 88 Park Place, New York, N. Y.
Electrical & radio testing instruments & accessories

Radio Transceiver Labs., 8627 115th St., Richmond Hill, New York
High frequency radio transmitters & receivers

Ranco, Inc., 601 West Fifth Ave., Columbus, Ohio
Refrigeration controls

Randall, Frank E., 248 Ash St., Waltham, Mass.
Machinists' dial gages

Rascher & Betzold, 829-835 Orleans St., Chicago, Ill.
Laboratory supplies

Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.
Dynamometers, wattmeters, milliammeters & voltmeters. Also ultra-sensitive meters both for A.C. & D.C., fluxmeters, electrostatic voltmeters, Thermocouples in vacuum, earth current meters, cable testers, milli-second timers

Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
Automatic & manually controlled rectifiers for all communication, industrial or laboratory applications

R. C. A. Manufacturing Co., Inc., Camden, N. J.
Radio & electronic equipment for all purposes including laboratory & industrial apparatus

Read Machinery Co., Inc., York, Penna.
Chemical & Industrial Equipment

Reed Small Tool Works, 40 Dewey St., Worcester, Mass.
Machine shop micrometers

Refinery Supply Co., 621 East Fourth St., Tulsa, Okla.
Gas testing instruments & specialties for oil & gas industry; & laboratory supplies

Refrigerating Specialties Co., 728 So. Sacramento Blvd., Chicago, Ill.
Automatic valves & regulators

Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Photoelectric equipment

Reich Mfg. Co., J. R., 43 East Stroup Road, Dayton, Ohio
Test indicators

Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio
Steam specialties

Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Electrical instruments

Remler Company, Ltd., 2101 Bryant St., San Francisco, Calif.
Radio & inter-communicating systems

Republic Flow Meters Co., 2249 Diversey Parkway, Chicago, Ill.
Remote reading flow meters, complete line of power plant & industrial instruments for the measurement of flow, level, pressure, draft, temperature & Co_2. Automatic boiler controls, regulators, valves and desuperheaters

Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, L. I., N. Y.
Protected & unprotected slide-contact rheostats & adjustable, wire wound resistors

Reynolds Gas Regulator Co., Anderson, Ind.
Automatic valves & regulators

Rhamstine, J. Thos., 500 E. Woodbridge St., Detroit, Mich.
Photoelectric cell equipment

Rhodes, Inc., M. H., 30 Bartholomew Ave., Hartford, Conn.
Time switches

Richardson Scale Co., Clifton, N. J.
Automatic weighing machinery

Riehle Testing Machine Division, American Machine & Metals Inc., East Moline, Ill.
Testing machines & testing instruments for tension, compression, bending, torsion, shear, hardness, wear

Rieker Instrument Co., 1919 Fairmount Ave., Philadelphia, Pa.
Scientific instruments

Ring-Balance Instrument Co., 740 N. Franklin St., Chicago, Ill.
Flow meters, draft & pressure gages for low pressure gas & air measurements. Recording, indicating & integrating in any combination

Riverbank Laboratories, Geneva, Ill.
Tuning forks

R & M Mfg. Co., Royal Oak, Mich.
Machine shop gages

Robertson & Co., John H., 1767 W. Armitage Ave., Chicago, Ill.

Robertson, 3rd, J. L., 116 Broad St., New York, N. Y.
Engine indicator accessories

Robertshaw Thermostat Co., Youngwood, Pa.
Thermostats

Robinson Orifice Fitting Co., 1435 Santa Fe Ave., Los Angeles, Calif.
Orifice fittings & plates

Rochester Mfg. Co., Inc., Rochester, N. Y.
Pressure & liquid level indicators & thermometers

Rockwell Co., Stanley P., 296 Homestead Ave., Hartford, Conn.
Dilatometers

Rogear Co., 11 Water St., New York, N. Y.

Roemer Drug Co., 606 N. Broadway, Milwaukee, Wis.
Laboratory supply house

Roller-Smith Co., Bethlehem, Pa.
Instruments (indicating & graphic), air & oil circuit breakers, relays, switchboards, precision balances, transformers, instrument & control switches

Rolnick Testing & Mfg. Co., 316 N. 22 St., Philadelphia, Pa.

Rowe Radio Research Laboratory Co., 1103 Bryn Mawr Ave., Chicago, Ill.
Specialized industrial & laboratory equipment, Electro-mechanical & electronic devices

Rubicon Co., Ridge Ave. at 35th St., Philadelphia, Pa.
Precision electrical instruments: potentiometers, galvanometers, bridges, resistance standards, for standardization, research, calibration of meters, production testing, & educational applications. Photoelectric colorimeters, transmission dynamometers & other special apparatus

Rueckert Manufacturing Co., 69 Sprague St., Providence, R. I.
Cases for instruments

Ruehfel Co., Inc., George, 103-105 Menahan St., Brooklyn, N. Y.
Laboratory instruments & apparatus

Rupp & Bowman Co., 315 Superior St., Toledo, Ohio
Laboratory supplies

Ruska & Co., Inc., Walter, 2332 Bellaire Blvd., Houston, Texas
Geophysical instruments

Ruth Glass Div., Kimble Glass Co., Conshohocken, Pa.
Laboratory glassware

Rutteo Mfg. Co., 103-04 Metropolitan Ave., Forest Hills, N. Y.

S

Sangamo Electric Company, Springfield, Ill.
Electric meters of all types; also instrument transformers, time-switches & radio condensers.

Sarco Company, Inc., 183 Madison Ave., New York, N. Y.
Temperature regulators

Sargent & Co., E. H., 155 E. Superior St., Chicago, Ill.
Laboratory supplies & chemicals

Saxl Instrument Co., Inc., 42 Weybosset St., Providence, R. I.
Precision instruments

Schaar & Co., 754 W. Lexington St., Chicago, Ill.
Laboratory supplies

Schade Valve Mfg. Co., 2527 N. Bodine St., Philadelphia, Pa.
Automatic valves

Schaefer Bros. Co., 1059 W. 11th St., Chicago, Ill.
Rheostats

Schaffer Poidometer Co., 2828 Smallman St., Pittsburgh, Pa.
Scales

Scherr Co., Inc., George, 128 Lafayette St., New York, N. Y.
Optical measuring & inspection equipment

Schettle's Frog Farm, 139 Sawyer Ave., Oshkosh, Wis.

Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.
Rotameters

Schwein Engg. Co., L. N., 5736 Washington Blvd., Los Angeles, Calif.
Aircraft instruments & pressure control instruments

Schweitzer & Conrad, Inc., 4435 Ravenswood Ave., Chicago, Ill.
High voltage testers, voltage detectors, & temperature indicators

Scientific Apparatus Co., 4 Landscape Ave., Yonkers, N. Y.
Laboratory apparatus

Scientific Glass Apparatus Co., Bloomfield, N. J.
Glass apparatus & interchangeable ground glass joints

Scientific Instrument Co., 1441 Walnut St., Berkeley, Calif.
Current meters

Scientific Instrument Co., 535 W. Larned St., Detroit, Mich.
Industrial & laboratory thermometers; hydrometers; special laboratory apparatus

Scientific Supplies Co., 123 Jackson Ave., Seattle, Wash.
Laboratory supplies
Scott Co., Henry L., Blackstone & Culver Sts., Providence, R. I.
Physical testing machines
Seederer-Kohlbusch, Inc., 149-151 New York Ave., Jersey City, N. J.
Analytical balances & weights
Seely Instrument Co., 2249 14th Street, S.W., Akron, Ohio
Temperature, pressure & time cycle controllers, indicating & dial thermometers, diaphragm valves
Selas Co., 18th & Indiana Ave., Philadelphia, Pa.
Indicating flow meters
Selsi Co., Inc., 43 W. 23rd St., New York, N. Y.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Electrical instruments measuring quantities or values of small current or voltage
Service Recorder Co., 1422 Euclid Ave., Cleveland, Ohio
Vehicle recorders
Shallcross Controls, Inc., 3707 N. Richards St., Milwaukee, Wisc.
Furnace controls
Shallcross Manufacturing Co., 10 Jackson Ave., Collingdale, Penna.
Rotary Selector Switches with solid silver contacts, accurate instrument resistors 0.1% — 5%, decade resistances & standards, bridges, telephone transmission test sets, resistance thermometers, bonding testers & special instruments for electrical measurements
Shawmut Engg. Co., 179 Freeport St., Boston, Mass.
Abrasion testers
Sheffield Gage Corp., 15 E. 3 St., Dayton, Ohio
Machine shop gages
Sheldon & Co., E. H., Muskegon, Mich.
Laboratory furniture
Sheldon Electric Corp., 100 Fifth Ave., New York, N. Y.
Photoelectric color matching machines

Shore Instrument & Mfg. Co., Van Wyck & Carll St., Jamaica, N. Y.
Scleroscope hardness testers

Sickles Co., F. W., Springfield, Mass.
Electrical products
Sigma Instruments, Inc., 388 Trapelo Rd., Belmont, Mass.
Relays
Simmonds Aerocessories, Inc., 10 Rockefeller Plaza, New York, N. Y.
Specialized aeronautical and engineering accessories
Simplex Time Recorder Co., Sanborn St., Gardner, Mass.
Simplex Valve & Meter Co., 68th & Upland Sts., Philadelphia, Pa.
Flow controls, meters, gages proportioning & ratio control equipment
Simpson Electric Co., 5216 Kinzie St., Austin Station, Chicago, Ill.
Electrical instruments
Sjostrom Co., John E., 1711 N. Tenth St., Philadelphia, Pa.
Laboratory furniture
Slocomb Co., J. T., 35 Oxford St., Providence, R. I.
Micrometer calipers
Sodemann Heat & Power Co., 2300 Delmar Blvd., St. Louis, Mo.
Air conditioned moist cabinet

Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.
Transformers, automatic voltage adjusters

Soltmann Inc., E. G., 250 East 43rd St., New York, N. Y.
Drawing & engineering materials
Sound Apparatus Co., 150 West 46th St., New York, N. Y.
Sound measuring equipment
Southwestern Electronics Labs., Box 1943 University Sta., Austin, Tex.
Electronic equipment
Southern Desk Co., Hickory, N. C.
Laboratory furniture
Sparling, R. W., 945 N. Main St., Los Angeles, Calif.
Liquid meters
Specialty Glass Co., 536 Lake Shore Drive, Chicago, Ill.
Laboratory glassware
Speedometer Electric Co., 699 Van Ness Ave., San Francisco, Calif.
Survey footmeter
Speidel & Co., Chas. W., 112 N. 12th St., Philadelphia, Pa.
Surveying instruments
Spence Engineering Co., Inc., 53 Grant St., Walden, N. Y.
Regulating valves

Spencer Lens Co., 19 Doat St., Buffalo, N. Y.
Microscopes, still projection equipment, instruments for measuring optical properties, crime detection instruments, & lenses, prisms & reflectors.

Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.
Thermostatic controls, temperature & pressure switches & relief valves, relays-thermal time delay
Sperry Gyroscope Co., Inc., Manhattan Bridge Plaza, Brooklyn, N. Y.
Aircraft & marine navigational instruments

Sperry Products, Inc., 1505 Willow Ave., Hoboken, N. J.
Special railway testers

Sperry-Sun Well Surveying Co., 1608 Walnut St., Philadelphia, Pa.
Underground surveying instruments for oil wells
Sprague Meter Co., 35 South Ave., Bridgeport, Conn.
Liquid meters
Spray Engg. Co., 114 Central St., Somerville, Mass.
Flowmeters
Standard Concrete Apparatus Co., 1422 Rhode Island Ave., Washington, D. C.
Concrete testing equipment
Standard Electrical Products Co., 317 Sibley St., St. Paul, Minn.
Relays

Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Electric stop clocks, electric time systems, watt hour meter testing equipment, program clocks, laboratory jack panels & small laboratory table service panels.

Standard Engineering Works, 289 N. Main St., Pawtucket, R. I.
Humidstats
Standard Scientific Supply Corp., 34 W. 4 St., New York, N. Y.
Laboratory supplies
Standard Thermometer, Inc., 65 Shirley St., Boston, Mass.
Mechanical thermometers
Star Brass Mfg. Co., 104 E. Dedham St., Boston, Mass.
Pressure & vacuum gages, gage testers
Star Compass Co., 110 Antwerp St., East Milton, Mass.
Compasses
Starrett Co., L. S., Athol, Mass.
Precision tools, dial indicators & steel tapes
States Co., Hartford, Conn.
Electricity meter testers
Steel City Testing Laboratory, 8843 Livernois Ave., Detroit, Mich.
Testing machines
Sterling Engineering Co., 3738 North Holton, Milwaukee, Wisc.
Motor operated valves
Stets Company, 141 Milk St., Boston, Mass.
Liquid level controllers, feed water regulators
Stewart-Warner Corp., 1826 Diversey Parkway, Chicago, Ill.
Tachometers

Sticht Co., Inc., Herman H., 27 Park Pl., New York, N. Y.
Electrical instruments

Stillman Co., M. J., Suite 800, 116 So. Michigan Ave., Chicago, Ill.
Stop watches
Stockton Profile Gauge Corp., 165 Jackson St., Lowell, Mass.
Profile gages
Stoelting Co., C. H., 424 N. Homan Ave., Chicago, Ill.
Laboratory supplies

Stokes Machine Company, F. J., Tabor Road, Olney, P. O., Philadelphia, Pa.
Special process machinery; pressure & vacuum gages; pellet presses; high vacuum pumps; McLeod vacuum gages; automatic water stills

Stover-Lang Co., 280 Dover St., Boston, Mass.
Tachometers
Streeter-Amet Company, 4101 Ravenswood, Chicago, Ill.
Automatic measuring, weighing & counting machines
Stromberg Time Corp., 107 Lafayette St., New York, N. Y.
Timing devices & time clocks
Struthers-Dunn see Dunn
Submarine Signal Co., 160 State St., Boston, Mass.
Sounding machines

Superior Electric Co., Bristol, Conn.
Industrial & laboratory apparatus

Superior Meter Co., Inc., 167 41st Street, Brooklyn, N. Y.
Gas meters & appliances
Supreme Electric Products Corp., 99 Mt. Hope Ave., Rochester, N. Y.
Solenoid valves, electro-magnets
Supreme Instruments Corp., Greenwood, Miss.
Radio testing equipment: tube testers, set testers, analyzers, test oscillators, oscilloscopes & dynamic instruments.
Suter, Alfred, 200 Fifth Ave., New York, N. Y.
Testing apparatus for textiles and metals

T

Taber Instrument Co., 111 Goundry St., North Tonawanda, N. Y.
Testers for measuring wear & abrasion resistance of paints, electroplate, linoleum, leather, textiles; precision stiffness gages for paper, light metallic sheet & wire

Tagliabue Mfg. Co., C. J., Park & Nostrand Ave., Brooklyn, N. Y.
Indicating, recording & controlling instruments for temperature, pressure, level, flow, humidity, hydrogen ion, time-cycle, including charts & recording inks; ebullimometers; flow meters; hydrometers; hygrometers; manometers; moisture meters; grain, wood, tobacco; mercurial vacuum gages; oil testing instruments, powders, liquids, granulated & sheet materials; potentiometers, indicating, self-balancing; pressure spring instruments, pyrometers, recorders, multiple point, high speed; recording pressure gages, relays, thermostatic; steam traps; switches, controller, rotary; thermocouples & pyrometer accessories; thermometers, chemical, dial-indicating, electrical, enclosed paper scale, industrial, recording, resistance; valves, Wheatstone & other bridges

Tally-Meter Co., 17 Elmwood Ave., Norwich, Conn.
Counters & measuring machines
Tamms Silica Co., 228 N. La Salle St., Chicago, Ill.
Pyrometers
Taylor & Co., Inc., W. A., 7300 York Road, Baltimore, Md.
Equipment for pH & chlorine control, control of phosphates in boiler water & for water analysis

Taylor Instrument Cos., 95 Ames St., Rochester, N. Y.
Indicating, Recording & Controlling Instruments for Temperature, Humidity, Pressure, Rate of Flow, & Liquid Level

Taylor Mfg. Co., 3056 West Meinecke Ave., Milwaukee, Wis.
Hydraulic dynamometers, static balancing machines, super-accurate drill presses
Technical Products Co., P. O. Box 93, Memphis, Tenn.
Laboratory supply house
Tejax Engineering Corp., 2 Allens Ave., Providence, R. I.
Dial indicating handwheels, valve position indicators & V-port hand regulating valves

Televiso Co., 2400 N. Sheffield Ave., Chicago, Ill.
Electronic products; custom built equipment

Teleweld, Inc., 80 E. Jackson Blvd., Chicago, Ill.
Hardness testers
Tenney Engineering, Inc., 46 Farrand St., Bloomfield, N. J.
Controlled temperature & humidity ovens
Test-A-Tone Co., 274 Madison Ave., New York, N. Y.
Stethoscopes
Testing Machines, Inc., 460 West 34th St., New York, N. Y.
Physical testing machines
Testrite Instrument Co., 57 E. 11th St., New York, N. Y.
Scientific instruments
Thermal Syndicate Ltd., 12 East 46th St., New York, N. Y.
Apparatus, laboratory; flats, optical; gas & vapor discharge tubes, mercury; light sources, mercury vapor; light sources; ultra-violet; optical parts
Therm-Electric Meters Co., Inc., Box 604, Ithaca, N. Y.
Indicating & recording thermal wattmeters, ampere and KVA meters of rating 5 to 50 amps. self-contained. Test panels & test boards for meter testing
Thermo-Electric Co., 1012 W. Superior Ave., Cleveland, Ohio
Electrically heated & controlled paraffin baths
Thomas Clocks, Seth, Div. of General Time Instruments Corp., Thomaston, Conn.
Household clocks, outdoor & tower clocks, clock movements for industrial purposes, also electric timers
Thomas Co., Arthur H., West Washington Square, Philadelphia, Pa.
Dealers, retail-wholesale-export, in laboratory apparatus & reagents for laboratories of chemistry & biology.
Thompson Clock Co., H. C., Bristol, Conn.
Electric stop clocks & interval timers
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Transformers

Thwing-Albert Instrument Co., Penn St. at Pulaski Ave., Philadelphia, Pa.
Pyrometers, paper testing instruments, portable pH meters, general testing instruments & machines

Tinsley Laboratories, 2035 Ashby Ave., Berkeley, Calif.
Astronomical instruments
Toledo Scale Co., 3216 Monroe St., Toledo, Ohio
Automatic scales for weighing, counting, check-weighing, compounding, force-measuring, weight-printing & weight-recording; & special devices for testing, classifying & standardizing.

Torsion Balance Co., 92 Reade St., New York, N. Y.
See Christian Becker, Inc.

Trerice Co., H. O., 1420 Lafayette Blvd., W., Detroit, Mich.
Industrial instruments
Triangle Package Machinery Co., 905 N. Spaulding St., Chicago, Ill.
Filling machines
Trill Indicator Co., 38 E. South St., Corry, Pa.
Engine indicators

Trimount Instrument Company, 408 South Plymouth Court, Chicago, Ill.
Manometers: well type, sliding scale U-tube, fixed scale U-tube, inclined, absolute pressure, & service; gages: draft & mercury pressure; indicating flow meters & tank level indicators

Triner Sales Co., 1440 Merchandise Mart, Chicago, Ill.
Scales

Triplett Electrical Instrument Co., 135 E. College Ave., Bluffton, Ohio
Electrical measuring instruments & radio testing equipment. Also instruments for laboratory and industrial test purposes; switches, relays, resistors, shunts

Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Radio test instruments
Troemner, Henry, 911 Arch St., Philadelphia, Pa.
Balances
Troy Tool & Gage Co., 5736 Twelfth St., Detroit, Mich.
Precision gages

U

Uehling Instrument Co., 14 Vesper St., Paterson, N. J.
CO_2 recorders, vacuum recorders, absolute pressure recorders, draft recorders, combined pressure & vacuum recorders, liquid level gages, pressure & vacuum gages, inclined draft gages, well-type direct reading manometers, U tube manometers, absolute pressure gages.
Ulanet Co., George, 86 E. Kinney St., Newark, N. J.
Thermostats
Ulmer Co., J. C., 1791 E. 38th St., Cleveland, Ohio
Surveying instruments
Unertl Optical Co., John, 412 Cemetery Lane, R.D. 4, Pittsburgh (9), Pa.
Optical instruments
Union Tool Company. Orange, Mass.
Machine shop gages
United Cinephone Corp., Torrington, Conn.
Electronic devices
United States Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
surveying instruments
United States Gauge Co., 44 Beaver St., New York, N. Y.
Indicating & recording pressure gages
United States Instrument Corp,, 19 So. Harrison St., E. Orange, N. J.
Voice powered telephone equipment
United Transformer Corp., 150 Varick St., New York, N. Y.
Transformers
University Apparatus Co., 2229 McGee Ave., Berkeley, Calif.

V

Vacutron, Inc., 2819 12th St. So., Arlington, Va.
Special vacuum tubes; electronic circuits & industrial control devices
Valpey Crystals, P. O. Box 321, Holliston, Mass.
Quartz crystals for frequency control
Valve Pilot Corp., 230 Park Ave., New York, N. Y.
Locomotive speed indicator & recorder and locomotive speed & cut-off indicator & recorder.
Van Keuren Co., 12 Copeland St., Watertown, Mass.
Optical comparators & flats
Vapor Recovery Systems Co., 2820 Alameda St., Compton, Calif.
Liquid level indicators
Vaughn-G. E. Witt Co., 4224 Hollis St., Oakland, Calif
Regulating valves
Veeder-Root, Inc., Sargent & Garden Sts., Hartford, Conn.
Counters, hub odometers
Vergilio Co., J. L., Erie Bldg., Cleveland, Ohio
Liquid meters
Veritas Firing System Co., P. O. Box 974, Trenton, N. J.
Seger cones
Vickers Inc., 1400 Oakman Blvd., Detroit, Mich.
Pumps & valving devices for control of power in oil-hydraulic systems
Victor Equipment Co., 844-50 Folsom St., San Francisco, Calif.
Absolute pressure gages
Viking Instruments Inc., Stamford, Conn.
Tachometers
Visco-Meter Corp., 315 Grote St., Buffalo, N. Y.
Viscosimeter
Voland & Sons, Inc., New Rochelle, N. Y.
Analytical balances & weights

W

Wadsworth Electric Mfg. Co., Inc., Covington, Ky.
Electric time switches
Wagner & Son, Carl H., 1944 N. Albany Ave., Chicago, Ill.
Thermometers
Walker & Co., Geo. T., 324 Fifth Ave., South, Minneapolis. Minn.
Laboratory supplies
Wallace & Tiernan Products, Inc., Belleville, N. J.
Chlorine control & chemical feed devices
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Timers
Waltham Dial Gage Co., Boxboro Road, Waltham, Mass.
Machinist's dial gages
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Resistors, rheostats, relays, motor starters, speed controllers, voltage regulators, electric control devices
Ward's Natural Science Estab., Inc., 302 N. Goodman St., Rochester, N. Y.
Warner & Swasey Co., 5701 Carnegie Ave., Cleveland, Ohio
Telescopes
Warren-Knight Co., 136 N. 12th St., Philadelphia, Pa.
Surveying instruments & equipment
Warren Telechron Co. Ashland, Mass.
Timers & fractional horsepower motors
Water Leak Detector Co., 166 N. Third St., Columbus, Ohio
Water leak detectors
Water Level Controls Co., 765 Hampden Ave., St. Paul, Minn
Liquid level controls
Watts Regulator Co., 10 Embankment St., Lawrence, Mass.
Automatic pressure regulating devices
Waugh Laboratories, Division of Waugh Equipment Co., 420 Lexington Ave., New York, N. Y.
Engineering field service for stress & vibration determination, instruments sale or rental basis, instruments designed & built.
Wayne Automatic Relay Co., 622 Wagner, Fort Wayne, Ind.
Photoelectric counters
Webber Co., Earl, 4348 W. Roosevelt Rd., Chicago, Ill.
Radio set analyzers
Weber Bros., Metal Works, 108 N. Jefferson St., Chicago, Ill.
Laboratory apparatus
Weber Co., F., 1220 Buttonwood St., Philadelphia, Pa.
Mathematical & surveying instruments
Weksler Thermometer Corp., 52-56 West Houston St., New York, N. Y.
Thermometers, hydrometers, psychrometers
Welch Engineering Service, F. M., Greenville, Ohio
Abrasion testing machines
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Electrical instruments, vacuum pumps & items for science laboratories.
West & Dodge Thread Gauge Co., Inc., 6 Power House St., Boston, Mass.
Screw thread gages
Western Electro-Mechanical Co. Inc., 300 Broadway, Oakland, Calif.
Load testing devices for a-c. circuits
Western Instrument Co., 5113 Kinsie St., Los Angeles, Calif.
Western Machinery Co., 306 W. Second St., Wichita, Kansas
Laboratory apparatus
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Switchboard, panel & portable measuring instruments, aircraft instruments, recorders, industrial & radio test set equipment
Westinghouse X-Ray Co. Inc., Long Island City, N. Y.
Industrial x-ray equipment
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Switchboard, panel & portable measuring instruments. Industrial & radio test equipment. Light measuring instruments & photographic exposure meters. Also dial type industrial temperature gages, control relays & aircraft instruments.
Wheaton Co., T. C., Millville, N. J.
Wheelco Instruments Co., 847 W. Harrison St., Chicago, Ill.
Temperature, indicating, recording & control instruments; temperature limit & shut-off device; automatic combustion safeguards
White Co., Inc., David, 315 W. Court St., Milwaukee, Wis. Surveying instruments
White Mfg. Co., 2362 University Ave., St. Paul, Minn. Furnace controls
White-Rodgers Electric Co., 1209 Cass Ave., St. Louis, Mo. Furnace controls
Wilcolator Co., 1001 Newark Ave., Newark, N. J.
Thermostats
Wilder Inc., R. S., 26 Bedford St., Waltham, Mass.
Microprojector
Wilder Sales Co., Drawer 70, Troy, N. Y.
Thermometers
Wilgus Mfg. Co., 1722 East 16th St., Los Angeles, Calif.
Diaphragm operated pressure regulators & combustion control equipment
Wilkening Mfg. Co., 1998 S. 71st St., Philadelphia, Pa. Piston ring gages
Wilkens-Anderson Co., 111 N. Canal St., Chicago, Ill. Laboratory supplies
Will Corp., 39 Russell St., Rochester, N. Y.
Laboratory supplies & apparatus
Williams Apparatus Co., Inc., Herald Bldg., Watertown, N. Y.
Pulp & paper testing equipment & flue gas analysis apparatus
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.
Laboratory supplies
Williams Gauge Co., 1620 Pennsylvania Ave., Pittsburgh, Pa.
Water level gages
Willson Products, Inc., Reading, Penna.
Anemometers
Wilson Mechanical Instrument Co., Inc., 383 Concord Ave., New York, N. Y.
Hardness testers
Winslow Co., Inc., 9 Liberty St., Newark, N. J.
Electrical instruments
Wollensak Optical Co., 880 Hudson Ave., Rochester, N. Y.
Optical instruments
Wood, Harry W., 4051 Suter St., Oakland, Calif.
Diaphragm valves and controllers
Woods "Lab. Apparatus", F. W., 140-6 Warden St., Pittsburgh, Pa.
Biological laboratory supplies
Woods Hole Oceanographic Inst., Woods Hole, Mass.
Oceanographic instruments
Worthington Gamon Meter Company, Harrison, N. J.
Liquid meters
Wright-Austin Co., 315 West Woodbridge St., Detroit, Mich. Power specialties
Wyland, George C., Center St., Ramsey, N. J.
X-Ray tubes & cameras

X

Xervac Instrument Co., 9 New Park Ave., Hartford, Conn.
Scientific instruments

Y

Yarnall-Waring Company, 102 E. Mermaid Ave., Chestnut Hill, Philadelphia, Pa.
Water columns, water gages & blow-off valves for steam boilers, spray nozzles for liquids & hydraulic valves for presses
Yonkers Lab. Supply Co., 515 W. 132 St., New York, N. Y.
Laboratory supplies

Z

Zeiss, Inc., Carl, 485 Fifth Ave., New York, N. Y.
Optical instruments
Zenith Electric Co., 603 So. Dearborn St., Chicago, Ill. Magnetic switches, work cycle timers
Zernickow Co., O., 15 Park Row, New York, N. Y.
Tachometers, Tachographs, Tachoscopes, cutmeters, stop watches
Zip Abrasive Co., Center & Washington Sts., Cleveland, Ohio Tachometers
Zuhr, Inc., Henry, 187 Lafayette St., New York N. Y. Laboratory test instruments

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BOOK REVIEWS

(Continued from page 81)

he believed—after "looking everywhere"—to have remained uninvestigated by any American or European laboratory!)

As a text-book, this treatise cannot be compared with any other of its kind, for it is unique. Its arrangement, however, (except for the final chapter) seems to be the result of years of actual experience in lecturing before diversified audiences at association meetings as well as before homogeneous classes of advanced students. Chapter I, of course, traces the analogies between light and electrons; and Chapter II (111 pages) presents a thorough discussion of the electron trajectory—a necessarily thorough discussion, because "the fields of force in which the electron motion takes place are for the most part inhomogeneous" (Preface). Chapter III (143 pages) combines mathematical and practical data on electron lenses. Likewise, Chapter IV not only discusses the classes and characteristics of aberrations but goes into highly practical details of various testing devices and various methods for minimizing or eliminating distortions and other undesirable effects.

The remainder of the book is mostly practical and up-to-late-1938. Chapter V takes up the different types of electron multipliers, Chapter VI treats vacuum technique, Chapter VII deals with electron microscopes and Chapter VIII covers "further applications."

Although the last figure number is "379," so many single numbers appear each under a plurality of diagrams or photographs that there probably are more than five hundred separate illustrations.

There are more than eight hundred references. They are arranged alphabetically by name. We can't resist saying "last but not least" about Dr. Zworykin who gets twenty-two citations. (Only v.Ardenne gets more: 24.) There are more than 1200 listings in the Index.

All in all, this first full-length treatise on a new science has been prepared with the thoroughness and finish of a many-times-revised classic. This book now *makes* electron optics a distinct science.

—M. F. Behar

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MANUFACTURERS' NEW LITERATURE

In this department we report ALL pieces of NEW literature pertaining to Instrumentation, received from the manufacturers. To assist in the War Effort we urge readers to request only those bulletins which will be of value to them.

J-1 **"Claud S. Gordon Company."** Booklet, 6" × 9", 8 pages, gives history of the company and describes its facilities. Claud S. Gordon Co., 1524 So. Western Ave., Chicago, Ill.

J-2 **Electronic Control System.** Booklet GEA-972A, 5¼" × 7¾", 8 pages, describes and illustrates new "Thy-motrol" electronic control system for the operation of d-c. motors from a-c. lines; provides stepless, wide-range speed control and the additional functions of starting, accelerating, protecting and stopping d-c. motors. General Electric Co., Schenectady, N. Y.

J-3 **Indicating Instruments.** Condensed Catalog No. C-10, 8 pages, describes and illustrates line of U-type and well-type manometers, draft gages, flowmeters, mercury pressure gages, tank gages and all accessories for measuring pressures, vacuums and flows of liquids and gases; contains size ranges, dimensions, weights and list prices. The Meriam Co., 1955 West 112th St., Cleveland, Ohio.

J-4 **Thermoswitches.** Folder containing Catalog Sections, each 2 pages, 8⅜" × 11", covers cartridge, air, hex head, immersion, block head, flange head, submersion, all-purpose and limited range 25-ampere capacity types of thermoswitches. Fenwal, Inc., Ashland, Mass.

J-5 **"General Radio Experimenter."** Nov. & Dec. 1941 issues, 4 and 8 pages respectively, contain Parts V and VI of "Impedance Bridges Assembled from Laboratory Parts," also articles on redesign of vacuum tube bridge and using cathode-ray oscillograph in frequency comparisons. General Radio Co., 30 State St., Cambridge, Mass.

J-6 **Recording Viscosimeter.** Sheet, 8¼" × 10¾", 1 page, describes and illustrates instrument for paints, pigments, varnishes, printing ink, adhesives, oils and greases, chocolate, ice cream, starch and any viscous material from a little above water to as heavy as paint pigment. Brabender Corp., Rochelle Park, N. J.

J-7 **Microphotometer.** Catalog E-90(1), 7¾" × 10½×, 12 pages, describes and illustrates the Knorr-Albers microphotometer which mechanically scans spectrographic plates or films and which, by means of a "Speedomax" recorder, automatically records on a wide-strip chart the relative positions and densities of spectrum lines. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

J-8 **Resistance Thermometers.** Catalog No. 9004, 7⅛" × 10½", 32 pages, covers thermometers for measuring and controlling relatively low temperatures in industrial processes, scientific work, refrigeration, air conditioning, etc. Illustrations of various types of resistance thermometers, control accessories, moisture-proof rotary switches, etc., are included. Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.

J-9 **"The Ohmite News."** Dec. 1941 issue, 2 pages, describes application of manufacturer's rheostats at a New York City radio transmitting station; contains item listing various types and sizes of resistors for industrial radio and electronic requirements. Ohmite Mfg. Co., 4835-41 Flournoy St., Chicago, Ill.

J-10 **Temperature, Indicating, Recording and Control Instruments.** Bulletin No. Z5000, 8½" × 11", 12 pages, covers line of remote controllers and auxiliaries, temperature control instruments, portable potentiometers, radiation heads, thermocouples and lead wire and "Flame-Otrols" and auxiliaries. Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

J-11 **"Permopivots" of "Permometal" for Precision Instruments.** Bulletin, 5⅜" × 8½", 4 pages, describes Permopivots for precision instruments, specially tipped with permometal, a platinum metals alloy (osium, ruthenium, etc.) said to be non-corroding, non-abrasive, wear resistant, non-magnetic and eliminates need of oil for lubrication. Permo Products Corp., 6415 North Ravenswood Ave., Chicago, Ill.

J-12 **Industrial Cleaning Machines and Cleaning and Rinsing Solutions.** Booklet, 5½" × 8½", 4 pages, describes and illustrates machine for precision cleaning of vital industrial units — instruments, meters, gages, bearings, clocks, etc., also lists cleaning and rinsing solutions. L & R Manufacturing Co., 54 Clinton St., Newark, N. J.

J-13 **Time Switches, Flashers and Interval Timers.** Form No. 33927, 3⅝" × 8¾", 6 pages, describes and illustrates line of time switches; on-and-off, alternates, four-in-one and other flasher types; and a number of types of interval timers—manual reset, automatic reset, adjustable cycle, program or signal timers, etc. Automatic Electric Mfg. Co., Mankato, Minn.

J-14 **Scientific Instruments and Photographic Materials.** Catalog 30, 8¼" × 11", 44 pages, covers line of instruments for spectroscopy, ultra violet ray fluorescence effects, special laboratory equipment and photographic supplies. Laboratory Specialties, Inc., 144 S. Wabash St., Wabash, Ind.

J-15 **Thermometers and Hydrometers.** Catalog No. 103, 8½" × 11", 48 pages, covers line of thermometers, hygrometers, barometers and hydrometers—red reading mercury, yellow back and red bore back types—for all industrial, technical and laboratory purposes. Philadelphia Thermometer Co., 915 Filbert St., Philadelphia, Pa.

J-16 **High Vacuum Pumps.** Catalog No. 38-P, 8½" × 11", 28 pages, covers the various models of high vacuum pumps giving structural features, operating principles, specifications and dimensions, charts and other information on vacuum and typical installations. F. J. Stokes Machine Co., Tabor Road, Olney P. O., Philadelphia, Pa.

J-17 **Dew Point Tester for Gases Under Pressure.** Folder, 4" × 8¼", describes and illustrates Bureau of Mines type for use in connection with the high pressure gas transmission lines — dew points can be measured with an accuracy of 0.2°F. The Refinery Supply Co., 621 East Fourth St., Tulsa, Okla.

J-18 **Testing Machines.** Booklet, 6" × 9", 20 pages, describes and illustrates hand- and power-operated Brinell hardness testers, Brinell microscope models with illuminator or with counter, indicator for direct-reading of tests, leveling table, calibrator for testing accuracy of hardness testers, metallographic grinder with ball bearings and sheet metal tester. Pittsburgh Instrument & Machine Co., 1026 Reedsdale St., Pittsburgh, Pa.

J-19 **Smoke Indicators.** Bulletin 413, 9½" × 11¾", 4 pages, describes and illustrates super sensitive visual type smoke indicators for guarding against objectionable smoke and indication of proper combustion hazes; and automatic combustion control with the Hazegage combustion indicator. Ess Instrument Co., 30 Irving Pl., New York City.

J-20 **Liquid Level Control.** Bulletin 412, 8½" × 11", 4 pages, describes and illustrates Faratron electronic control — no floats, no moving parts, non-mechanical —an electronic switch for controlling level of water, syrup, oil, milk, etc. in any type of container open or closed. Lumenite Electric Co., 407 South Dearborn St., Chicago, Ill.

J-21 **Engineering Data Covering Resistors and Controls.** Loose-leaf Binder, 9" × 11½", 44 pages, contains data sheets on resistors, controls and resistance devices for the radio, television, electronic, electrical and aeronautical industries. Clarostat Mfg. Co., Inc., 285 North 6th St., Brooklyn, N. Y.

J-22 **Low Power Photomicrography.** Catalog F-19, 8½" × 11", 4 pages, describes and illustrates micro tessars and tessar IIb lenses designed for low power photomicrography. Price list attached. Bausch & Lomb Optical Co., 615 St. Paul St., Rochester, N. Y.

J-23 **Gages and Dial Indicators.** Catalog No. 52, 8½" × 11", 40 pages, describes and illustrates a number of dial indicator models, dial micrometers, thickness measures, upright gages and cylinder gages. B. C. Ames Co., Waltham, Mass.

J-24 **Production Counter.** Catalog Section No. 16, 8½" × 11", 2 pages, describes and illustrates new magnetic counter operated by photocell and a beam projector. The interruption of the light beam by an object actuates the electric counter. Durant Mfg. Co., 1929 North Buffum St., Milwaukee, Wis.

J-25 **Panel Instruments.** Catalog A, 8½" × 11", 12 pages, covers line of electrical instruments of the d-c. D'Arsonval moving coil, a-c. double iron repulsion and electro-dynamometer types; also several precision portables. The Triplett Electrical Instrument Co., Bluffton, Ohio.

J-26 **Aircraft Instruments.** Booklet, 5¼" × 7", 50 pages, covers altimeters, air speed indicators, Pitot static tubes, aviation clocks, direction indicators, aviation compasses, free air thermometer, vertical speed indicator, engine and miscellaneous instruments. Kollsman Instrument Div., Square D Co., 80-08—45th Ave., Elmhurst, N. Y.

J-27 **Rotary Selector Switches.** Bulletin, 8½" × 11", 4 pages, covers thermocouple and resistance thermometer switches, also special thermocouple switches. Includes drilling dimensions for mounting switches flush on panels. Lewis Engineering Co., Naugatuck, Conn.

J-28 **Insulation Resistance Testing Instruments.** Bulletin No. 430, 8¼" × 10¾", 8 pages, describes model B-5 Megohmer with range of 0-200 megohms for insulation tests, 0-2000 ohms for low resistance measurements and has two d-c. voltmeter scales 0-300 and 0-600 volts. Herman H. Sticht Co., Inc., 27 Park Pl., New York City.

J-29 **Rotary Instrument Switches.** Bulletin SW, 8½" × 11", 1 page, covers Types "EN" and "BS" switches for instrument and industrial field; gives applications, construction data and general specifications. J-B-L Instrument Co., P. O. Box 135, Darby, Pa.

J-30 **Dynamic Hardness Tester.** Bulletin, 8½" × 11", 4 pages, describes and illustrates Model No. 7 hardness tester for metals, plastics and industrial materials. Instrument is 4¼" × 4¼" × 1¼"; weighs 13 oz. and is furnished in a leather covered case. The R. Y. Ferner Co., 131 State St., Boston, Mass.

J-31 **Pressure and Temperature Recorders.** Bulletin No. 111, 7¾" × 10½", 24 pages, describes Type K35 recorders including a table of the different types of measuring elements. A number of typical installations are illustrated in various industries. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

J-32 **Electron Microscope.** Bulletin, 8¾" × 11⅝", 24 pages, covers electron microscope with magnifications up to 100,000 diameters, describes its operation and shows fields in which it may be applied. RCA Manufacturing Co., Inc., Camden, N. J.

J-33 **Projection Reading Analytical Balance.** Bulletin No. 680, 3¾" × 8⅝", 4 pages, describes and illustrates analytical balance No. 911 for automatic weighings from 1/10 mg. to 100 mg. ±. Illuminated and graduated micro scale is magnified, projected and read on a matt glass screen. Christian Becker, Inc., 92 Reade St., New York City.

J-34 **Midget Magnetic Relays.** Bulletin 106, 8" × 10½", 2 pages, covers relays for use on a-c. or d-c. and can be equipped with single- or double-pole and single- or double-throw contacts. Standard relays are of the open type mounted on a molded insulating base. Ward Leonard Electric Co., 38 South St., Mount Vernon, N. Y.

J-35 **Portable Hardness Tester.** Circular F 1689, 3¾" × 8½", 4 pages, describes and illustrates the "Impressor" for testing hardness of metals or plastics after fabrication—aluminum, aluminum alloys and soft metals. Barber-Colman Co., Rockford, Ill.

J-36 **Tachometer and Vibration Indicator.** Bulletin 1700, 7¾" × 10½", 4 pages, describes and illustrates "Frahm" tachometer for speed measurement and rates of vibration. Also lists mechanical indicating tachometer, chronometric speed indicator, tachoscope and stroboscope. James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa.

J-37 **Radio Laboratory Instruments.** Booklet, 6" × 9", 16 pages, describes and illustrates signal generators, calibrator, microvolters and accessories — external modulation coupling unit and audio oscillator, radio noise and field strength meter and crystal controlled generator. Ferris Instrument Corp., Boonton, N. J.

J-38 **Automatic Furnace Draft Control for On and Off Firing Equipment.** Publication No. 41-489, 8½" × 11", 8 pages, covers construction, operation and applications of Type CSESS automatic sequence furnace draft controller. The Hays Corp., Michigan City, Ind.

J-39 **Steam Heating Control.** Folder, 8½" × 11" 6 pages, describes and illustrates pneumatic "Duo-Stat" weather-compensated heat regulator for all types of automatic firing devices. Johnson Service Co., 1355 Washington Blvd., Chicago, Ill.

J-40 **Salt Spray Corrosion Test Equipment.** Bulletin, 8½" × 11", 2 pages, describes and illustrates equipment designed to determine the corrosion resisting qualities of electroplated or coated metal, alloys, metal parts, lacquered or painted samples, etc. Industrial Filter & Pump Co., 3017 West Carroll Ave., Chicago, Ill.

J-41 **Galvanometers for Seismic Recorders.** Folder SG-1, 8½" × 11", 6 pages, describes and illustrates coil galvanometers and 12 channel camera for coil type and oscillograph galvanometers for 6 element cameras. Heiland Research Corp., 700 Club Building, Denver, Colo.

J-42 **Moisture Control System.** Bulletin 212-2, 8½" × 11", 16 pages, describes and illustrates "Verigraph" system which measures and controls the equilibrium moisture content of the paper web during manufacture. The Foxboro Co., 46 Neponset Ave., Foxboro, Mass.

J-43 **Dosage Meter.** Circular "F", 8½" × 11", 2 pages, covers safety device for protection of workers using radium and radium luminous material, indicating gamma-ray intensity and locating lost or misplaced radium. Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.

J-44 **Flowmeters** Publication 3010, 8½" × 11", 52 pages, covers instrument application to steam, water, air, gas and viscous, volatile and corrosive fluid measurement. Special sections are devoted to control applications, dual range recorders, detached instruments and summation meters. A list of available charts is included. Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia, Pa.

J-45 **Rheostats and Potentiometers.** Catalog R-61, 8½" × 11", 4 pages, covers heavy duty rheostats and potentiometers for spot welding, mixing panels, motor control, electronic devices, radio transmitters, dynamic voltage control, portable power amplifiers, primary power circuits, electroplating and laboratory work. DeJur-Amsco Corp., Shelton, Conn.

J-46 **Scientific Laboratory Apparatus.** Catalog 341, 8" × 11", 1216 pages, covers entire line of chemical, metallurgical, physical, clinical, biological and bacteriological apparatus. All requests for this catalog should be directed to manufacturer on company letterhead. Burrell Technical Supply Co., 1935 Fifth Ave., Pittsburgh, Pa.

J-47 **Heat Controls.** Bulletin, 8½" × 11", 4 pages, describes and illustrates models of controllers for temperatures as low as —100° or as high as 1400°F., gives diagram of installations, mounting equipment and comparative temperature chart. Burling Instrument Co., 253 Springfield Ave., Newark, N. J.

J-48 **Portable Humidity Recorders.** Bulletin 554a, 8" × 10½", 6 pages, describes and illustrates Models 4069TH without fan — natural circulation and F4069TH "Thermo-Humidigraph" with fan. Instruments record in colored ink on circular charts the per cent relative humidity of the atmosphere surrounding them. The Bristol Co., Waterbury, Conn.

J-49 **Polarizing Microscopes.** Catalog, 7" × 10", 26 pages, describes and illustrates microscopes for use in the sciences and industries — medical, ceramics, mining, petroleum, textile and paper industries and industrial hygiene, botanical, and food and drugs. Spencer Lens Co., 19 Doat St., Buffalo, N. Y.

J-50 **Constant Voltage Transformers.** Bulletin CV-74, 8½" × 11", 22 pages, describes and illustrates transformers which deliver a constant output voltage, independent of transient or continuous variations in supply voltage. Covers construction, operation and applications of transformers. Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.

J-51 **Precision Balances.** Catalog 4540, 8½" × 11", 8 pages, describes and illustrates Models B, C and D balances for determination of the weight of small objects or materials where a number of weighings of approximately the same value must be made, and surface tension balance designed for measuring the surface tension of liquids. Roller-Smith Co., 1766 Market St., Bethlehem, Pa.

J-52 **Liquid Measurement.** Bulletin, 8½" × 11", 8 pages, discusses measurement with the King-Gage, formerly K-S Telegage, an instrument to determine the liquid level, or liquid content, of any type of tank, vat or container. King Engineering Corp., Ann Arbor, Mich.

J-53 **Electronic Micrometer.** Bulletin, 8½" × 11", 4 pages, describes and illustrates Carson electronic micrometer for precision measurements without pressure on soft, flexible, or compressible materials—measures thickness to 0.0001" on rubber, fabric, cork, foil, felt, fiber, plastics, paint films or paper. Instrument Specialties Co., Inc., Little Falls, N. J.

J-54 **Metal Shielded Wire.** Folder, 8½" × 11", 4 pages, describes and illustrates wire which provides new method of shielding insulated wire or wires with seamless aluminum or copper tubing. Can be made in different combinations from a single conductor with an outside diameter of .018" to multi-cable types up to 1" outside diameter. Precision Tube Co., 3824-26-28 Terrace St., Philadelphia, Pa.

J-55 **Scientific Apparatus — Physical, Chemical and Biological.** Catalog, 7¾" × 10½", 652 pages. This is the 1942 Welch catalog which is divided into fourteen main sections as follows: measurements, mechanics of fluids, heat, magnetism and static electricity, current electricity, sound and light, balances and weights, chemical apparatus, chemicals, biological apparatus and supplies, charts and models, microscopes, specimens living and preserved and prepared microscopic slides. Sent without charge to all who have an educational, research, or industrial laboratory connection. ("We obviously cannot afford to distribute a comprehensive catalog of this kind to students who might see our catalog on an instructor's desk, etc.") W. M. Welch Mfg. Co., 1515 Sedgwick St., Chicago, Ill.

J-56 **Automatic Control Equipment.** Catalog No. 41, 8¾" × 11", 24 pages, describes and illustrates control equipment for temperature, rate of flow, pressure and liquid level. Mason-Neilan Regulator Co., 1185 Adams St., Boston, Mass.

J-57 **Recording Instruments for Temperature and Pressure.** Catalog No. 1210, 8½" × 11", 26 pages, covers line of mercury-actuated, vapor tension and gas-filled recording thermometers; also hygrometers, time-operation recorders, psychrometer and pressure and vacuum recording gages. C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.

J-58 **Valves for Refinery Operations.** Catalog, 104 pages, plastic bound, presents 98 "Nordco" steel valves and 121 semi-steel valves, includes standard types, hypreseals, steam jacketed, multiports and flexible coupling adaptations, with wrench, worm or spur gear operation. Air, meter and service cocks are also listed and a newly revised table of "Nordco" lubricants. Merco Nordstrom Valve Co., 400 Lexington Ave., Pittsburgh, Pa.

J-59 **"The Hydromike."** Vol. 4, No. 4, 8½" × 11", contains items on level and flow controls and on the Stevens simplified Venturi tube. Leupold, Volpel & Co., 425 N. E. 70th Ave., Portland, Oregon.

J-60 **Liquid Level Measurement.** Bulletin, 8½" × 11", 8 pages, describes and illustrates liquid level gage — showing the indicator panel, junction box, control mechanism, pulley compartment and tank head gaging unit, which houses the control mechanism and pulley. Guardian Elec. Mfg. Co., 1627 West Walnut St., Chicago, Ill.

J-61 **Ground Resistance Tester.** Bulletin 251, 8½" × 11", 4 pages, describes and illustrates new "Model 251 Vibroground" designed for testing resistance to earth of ground rods and is of the synchronous self-rectifying type. Associated Research, Inc., 431 So. Dearborn St., Chicago, Ill.

J-62 **Time Control of Reversal.** Bulletin T-31, 8½" × 11", 2 pages, describes and illustrates firing-reversal timers for use in controlling the firing of regenerative furnaces, typical applications covered are in the steel and glass industries. Automatic Temperature Control Co., 34 E. Logan St., Philadelphia, Pa.

J-63 **Universal Hydraulic Testing Machines.** Bulletin, 8½" × 11", 4 pages, covers Model 505 testing machines up to 60,000 lbs. capacity, for compression, tension and transverse testing. Riehle Testing Machine Div. of American Machine & Metals, Inc., East Moline, Ill.

J-64 **Instrument Panelboards.** Bulletin 8¼″ × 10¾″, 4 pages, describes and illustrates line of instrument panels — self-supporting cubicle-type, flat plate panel with structural supports, standard unit panel with stock supports and braces, special type draft gage board, etc. Falstrom Co., Passaic, N. J.

J-65 **"Electroencephalograph."** Bulletin, 5″ × 8½″, 6 pages, announces new Junior "Electroencephalograph" apparatus for the recording of electrical potentials originating in the brain. Electro-Medical Laboratory, Inc., Holliston, Mass.

J-66 **Cathode-ray Oscillograph.** Bulletin, 6″ × 9″, 8 pages, describes and illustrates Type 208 oscillograph with distortionless input-attenuator, newly developed amplifier circuit among its features. Allen B. DuMont Labs., Inc., 2 Main Ave., Passaic, N. J.

J-67 **Plaster Tester.** Bulletin, 8½″ × 11″, 2 pages, describes and illustrates "Kaydel" plaster tester for determination of moisture. Instrument dimensions 2⅞″ × 1¾″ × 5½″; weight 20 oz., extension contactor with 4½ ft. cable is available as accessory. Hart Moisture Gauges, 126 Liberty St., New York City.

J-68 **"Hydron Metallic Bellows."** Catalog, 8½″ × 11″, 44 pages, describes and illustrates Hydron bellows — includes tables of sizes and characteristics of standard and extra flexible bellows and a life prediction chart, discusses assembling, soldering and cleaning, application of Hydron bellows assemblies for remote control of temperatures; section on instructions for ordering thermostatic units and a large chart of vapor pressure—temperature curves of typical filling mediums. Clifford Mfg. Co., 564 East First St., Boston, Mass.

J-69 **Metal Bellows and Bellows Assemblies.** Bulletin No. 130, 8½″ × 11″, 28 pages, catalogues seamless metal bellows and assemblies for use by instrument, appliance and machinery manufacturers, covers applications of seamless metal bellows, both roll-formed and hydraulically-formed in single and multi-ply types. The Fulton Sylphon Co., Knoxville, Tenn.

J-70 **"Cornell-Dubilier Capacitor."** Vol. 5, No. 9, 16 pages, contains article entitled "A Flexible Plug-In Tester," also a number of items on radio service hints. Cornell-Dubilier Electric Corp., New Bedford, Mass.

J-71 **Variable Transformer.** Bulletin No. 149, 8½″ × 11″, 12 pages, describes and illustrates Powerstat auto-transformer for obtaining continuously variable output voltage from a-c. power lines, also covers various applications. Superior Electric Co., 130 Harrison St., Bristol, Conn.

J-72 **Automatic Solution Control.** Bulletin, 8½″ × 11″, 2 pages, covers Type RE Solu-Bridge controller which indicates concentration of a solution in percentage, parts per million or other terms, operates a visual or audible warning, or controls a valve or other corrective means when concentration exceeds or falls below set limit. Industrial Instruments, 156 Culver Ave., Jersey City, N. J.

J-73 **Rotameters.** Catalog Section 50-A, 8½″ × 11″, 8 pages, covers electrically operated, remote indicating, recording and integrating Rotameters. Several different types of transmitting systems including mechanical, magnetic, electronic and inductive are used, with this catalog section being devoted to induction bridge transmitter types. Fischer & Porter Co., 24 County Line Rd., Hatboro, Pa.

J-74 **Industrial Analyzer.** Sheet, 8¾″ × 11¼″, 1 page, covers Model 77 a-c. power analyzer for complete power tests—3 phase, 2 phase and single phase. Measures values from ⅛ amp. to 300; watts from 15 to 240,000; voltages of circuits nominally 110-220-440-550. Niagara Electrical Instrument Co., 1 West Genesee St., Buffalo, N. Y.

J-75 **Relays and Control Apparatus.** Catalog CC-1, 9″ × 11″, 14 pages, covers line of d-c. relays, electric counters, contact assemblies, mercury contact relays, keys, plugs, jacks, terminal blocks and pilot switches; supplement sheets on Type G micro switch relay and lever keys. C. P. Clare & Co., Lawrence & Lamon Aves., Chicago, Ill.

J-76 **Dissolved Oxygen Recorder.** 3 sheets, 8½″ × 11″, describes and illustrates oxygen recorder with 10″ strip chart, chart speed of 1″ per hour. Standard ranges of the instrument are 0-1 p.p.m. dissolved oxygen or 0-2 cc. per liter. Schematic diagram included. Cambridge Instrument Co., Inc., Grand Central Terminal, New York City.

J-77 **Condensers, Resistors and Test Instruments.** Catalog, 8½″ × 11″, 20 pages, covers general line of electrolytic, paper, oil, exact-duplicate replacements, transmitting and other condensers, wire-wound and carbon resistors, and L-C checker, capacity-resistance bridge and motor-starting capacitor selector. Aerovox Corp., New Bedford, Mass.

J-78 **Aircraft Compass.** Bulletin, 8½″ × 11″, 2 pages, describes and illustrates Type CG compass, mounting dimensions conform to AN and SAE standards for 2¾″ dial instruments, spherical bowl is of phenolic composition (a hot molded plastic), front glass of magnifying type. Elgin National Watch Co., Precision Products Div., Elgin, Ill.

J-79 **Portable Electrical Instruments.** Bulletin P-10-1, 8⅝″ × 10¾″, 8 pages, covers d-c. Model P-11 permanent magnet moving coil type voltmeters, millivoltmeters, microammeters, milliammeters, ammeters and volt-ammeters; a-c. Model P-12 moveable iron type, a-c. Model P-13 rectifier type and a-c. Model P-14 thermocouple type; portable testing shunts and electric tachometers. The Winslow Co., Newark, N. J.

J-80 **"The Technique of Square Wave Analysis."** Bulletin, 8½″ × 11″, 4 pages, discusses square wave analysis and describes and illustrates Model 71 square wave generator; price included. Measurements Corp., Boonton, N. J.

J-81 **Time Delay Relay.** Bulletin N-4, 8½″ × 11″, 8 pages, describes and illustrates the "Agastat" for introducing a time delay in electrical circuits, designed for use in conjunction with any electrical apparatus requiring a delay interval; gives contact arrangements, mountings and applications. American Gas Accumulator Co., Elizabeth, N. J.

J-82 **Mercury Plunger Relays.** Bulletin "B", 8½″ × 11″, 4 pages, covers relays designed to operate in any position within 45° of the vertical; among features are one moving part, mercury to mercury break, up to 30 ampere or one h.p. a.c. rating. H-B Electric Co., Inc., 2518 North Broad St., Philadelphia, Pa.

J-83 **Rheostats.** Bulletin S, 8¼″ × 10½″, 6 pages, describes and illustrates line of rheostats including tubular slide-contact, four-range, table rotary drive, vertically mounted and motorized types and adjustable resistors. Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, L. I., N. Y.

J-84 **Centrifugal Tachometers.** Bulletin, 8½″ × 10¾″, 4 pages, describes and illustrates single-range hand, stationary and triple-range types of tachometers, includes prices. Boulin Instrument Co., 65 Madison Ave., New York City.

J-85 **Torque Testing Machine.** Bulletin TM 1, 8½″ × 11″, 5 pages, describes Torquemeter, instruments and auxiliary equipment for the determination of torsional or frictional resistances in bolts, crankshafts, twist drills, bearing surfaces and other equipment. Waugh Laboratories, 420 Lexington Ave., New York City.

J-86 **Air Meters.** Bulletin A-7, 8½″ × 10¾″, 4 pages, describes and illustrates compressed air meter for measuring the air consumption of any pneumatic tool, rock drill, air motor, sand blast, air lift or other application of compressed air. New Jersey Meter Co., Plainfield, N. J.

J-87 **Ceramic Cut-Off Saw, Optical Glass Spindle and Automatic Polishing Spindle.** Three bulletins, 8½″ × 11″, 1 page each, show cut-off saw for ceramics, synthetics or metals, multi-spindle hand correcting machine and polishing machine for optical glass. Baily Vibrator Co., 1539 Wood St., Philadelphia, Pa.

J-88 **Precision Timers.** Bulletin No. 113, 3½″ × 6″, 16 pages, covers electric precision timers for measuring and indicating elapsed-time intervals, also chrono-tachometer for testing engine performance by integrating revolutions and time. Standard Electric Time Co., Springfield, Mass.

J-89 **Instrument Cases.** Circular, 12″ × 6¼″, 2 pages, describes and illustrates leather and hardwood finished cases for precision tools and instruments—gages, indicators, micrometers, vernier calipers, optical instruments, drawing instruments, surgical instruments, etc. Rueckert Mfg. Co., 69 Sprague St., Providence, R. I.

J-90 **Hand and Stationary Tachometers.** Two Bulletins, 8½″ × 11″ 10 pages combined, describes and illustrates multiple-range hand tachometer in carrying case—Type B Class A, and stationary industrial type with various types of mountings shown. Jones-Motrola Sales Co., 432 Fairfield Ave., Stamford, Conn.

J-91 **Indicating Calipers.** Folder, 8½″ × 11″, 4 pages, describes and illustrates two-inch and three-inch indicating calipers—the two-inch calipers are graduated in 1/1000 inches; three-inch calipers in 1/64 inches. Metric system types are covered, also special calipers. Indicating Calipers Corp., 506 East 19th St., New York City.

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J-92 **Optical Pyrometers.** Catalog No. 80, 8½" × 11", 6 pages, covers characteristics and applications of "Pyro" optical pyrometer. Pyrometer Instrument Co., 103 Lafayette St., New York City.

J-93 **Electric Detector for Tubes.** Bulletin 91, 8½" × 11", 4 pages, describes and illustrates detector for ferrous and non-ferrous metals—Type B-1-B for low sensitivity and C-1-A for high sensitivity; a number of illustrations show types of defects detected. Sperry Products, Inc., 1505 Willow Ave., Hoboken, N. J.

J-94 **Recording Sound Frequency Analyzer.** Bulletin, 8½" × 11", 6 pages, describes and illustrates RA-281 analyzer consisting of three units—a sound frequency analyzer, special graphic level recorder and either a moving coil microphone or moving coil vibration pick-up. Equipment is portable—intended for field testing as well as laboratory use. Electrical Research Products, 76 Varick St., New York City.

J-95 **Pyrheliometer.** Bulletin No. 2, 8½" × 11", 6 pages, discusses instruments primarily designed for the measurement of the intensity of solar radiation falling upon a horizontal plane. Graphic records are shown of Nos. 294 and 263 (weather bureau types) pyrheliometers used in conjunction with a recorder. Prices included. The Eppley Laboratory, Inc., Newport, R. I.

J-96 **Temperature Gages.** Catalog T-11-C, 8½" × 11", 12 pages, covers line of industrial temperature gages, testing thermometers, general-purpose angle form and heavy duty angle form and straight form temperature gages; also accessories for gages. Weston Electrical Instrument Corp., 591 Frelinghuysen Ave., Newark, N. J.

J-97 **Miniature Ball Bearings.** Bulletin No. 4, 8½" × 11", 6 pages, shows R.M.B. bearings available in sizes ranging from 1.5 millimeters up to 20 millimeters outside diameter. Designed for small motors, recorders, clock-work mechanisms, weighing devices, speed indicators, pressure gages and other precise apparatus. Price list and discount sheet included. Landis & Gyr, Inc., 104 Fifth Ave., New York City.

J-98 **Galvanometers.** Bulletin No. 320, 8½" × 11", 12 pages, describes and illustrates Type T high sensitivity, Type W wall, d.c. spotlight, a.c. spotlight, a.c. pointer, d.c. pointer and the new Type L and "Pointerlite" galvanometers; also new Ayrton shunts and accessories. Rubicon Co., Ridge Ave. at 35th St., Philadelphia, Pa.

J-102 **Temperature Instruments.** Catalog No. 42, 8⅝" × 11¼", 14 pages, describes and illustrates 6" square case dial, 6", 5", 4½" and 3½" dial thermometers, 6", 10" and 12" recording thermometers, straight form and angle form brass case types, kettle, tank and iron case and cylinder case thermometers. Gotham Instrument Co., 149 Wooster St., New York City.

J-99 **Electrical Instruments.** Catalog No. 22, 8⅜" × 11", 26 pages, describes and illustrates line of standard laboratory, portable and panel mounting instruments — a.c.-d.c. milliameters, voltmeters, ammeters, wattmeters, etc.—and new volt-ampere-wattmeter, electrical appliance tester and circuit analyzer; also external shunts and current transformers for panel mounting instruments. A number of aircraft electrical indicating instruments are shown. Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

J-100 **Vacuum Thermocouple.** Bulletin, 8½" × 11", 4 pages, describes and illustrates thermocouple consisting of a thermo-junction and a heater-filament mounted in an evacuated glass bulb; applications include use in electrical communication: the telephone and radio, electro-medical industry in x-ray, diathermy and therapeutic equipment and commercial and educational electrical research work. American Electrical Sales Co., Inc., 67 East 8th St., New York City.

J-101 **Fractional Horsepower Motors.** Bulletins 1023 and 1024, 8" × 10½", each 4 pages, describes and illustrates Type K frame motor, only 2⅝" high, and built-in spur gear speed reducer motors — synchronous or non-synchronous, speeds from 300 r.p.m. to 1 r.p.m., torque 1.3 to 120 inch ounces, especially designed for use on instruments and control apparatus. Bodine Electric Co., 2254 West Ohio St., Chicago, Ill.

J-103 **Instruments and Controls.** Catalog No. 41-1, 8½" × 11", 12 pages, covers complete line of equipment including control systems, CO_2 meters, desuperheaters, draft instruments, flowmeters, liquid level instruments, multiple reading indicators and recorders, master panelboards, pressure instruments, regulators, thermometers and pressure reducing and regulating valves. Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.

J-104 **Surface Analyzer.** Technical Bulletin No. 552, 8½" × 11", 11 sheets, describes and illustrates SA-2 surface analyzer designed for making instantaneous and permanent chart records of irregularities in finished surfaces such as metals, glass, plastics, plated and painted surfaces, paper, etc. Irregularities of less than one microinch (1,000,000th of an inch) may be accurately recorded. The Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio.

J-105 **Resistors, Attenuators and Measuring Equipment.** Catalog, 8¾" × 11", 70 pages, covers line of broadcast, sound picture, television and electrical apparatus components and laboratory test equipment including output power meters, volume level indicators, power level indicators, decade voltage divider, logarithmic resistor and program line equalizer. The Daven Co., 158 Summit St., Newark, N. J.

J-106 **Flight Analyzers.** Descriptive and instruction sheets, cover the Nos. 640, 643 and 644 analyzers—640 especially designed to chart altitude of aircraft during flight in terms of barometric pressure, and electrically actuated operations pens record the time during which any particular equipment is used; No. 643 analyzer records air speed, vertical acceleration, altitude and two operations and 644 makes records of information given on the Autosyn system. Julien P. Friez & Sons, Baltimore St. & Central Ave., Baltimore, Md.

J-107 **Meters for All Liquids.** Booklet, 8¼" × 11", 16 pages, describes and illustrates meters for oils, gasoline, water and chemicals—and high pressure, electri-contact, molasses, beer and wine, paint, grease, and other meters; also vertical and horizontal meter dials, trap strainers and air release valves. Gives data on capacities, care of meters, dimensions and installation. Buffalo Meter Co., 2917 Main St., Buffalo, N. Y.

J-108 **Enclosing Cabinets for Electrical Devices.** Catalog No. 22, 8¾" × 11¼", 22 pages, covers line of Type "A" surface and special cabinets, screw cover pull boxes, weatherproof cabinets, slant roof, Type "P" flush, guttered type and panelboard cabinets; also conduit fittings, breaker boxes and "Safe-T-Cirkits" for grounded neutral installations. Columbia Metal Box Co., 260 East 143rd St., New York City.

J-109 **Pressure and Vacuum Gages.** Bulletin, 8¼" × 10⅝", 12 pages, covers line of pressure types industrial heavy duty, standard pressure, altitude, compound-pressure and vacuum, retard-vacuum and refrigeration gages, combination thermometer-pressure and altitude gage and water pressure test gage. Certified Gauge & Instrument Corp., 34-18 Northern Blvd., Long Island City, N. Y.

J-110 **Voltage Stabilizers.** Bulletin DL48-71L, 8½" × 11", 4 pages and price sheet DL48-444, describe and illustrate stabilizers with varying input voltage 95-130 volts and constant output voltage 115 volts ±½%, covers cased and uncased models and includes dimension tables. Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.

J-111 **Small Spectrometer.** Bulletin 144-04, 8½" × 11", 4 pages, describes and illustrates small spectrometer for use in research laboratories when the highest precision is not required, shows polarizing attachment and spectrometer accessories. The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.

J-112 **Gas Appliances.** Catalog No. 41, 8½" × 11", 20 pages, covers line of appliances including burners, torches, pot-hardening and melting furnaces, heat-treating furnaces, blowers, valves, soldering furnaces, conversion burner, soldering fluid and automatic air-gas proportioner. Johnson Gas Appliance Co., Cedar Rapids, Iowa.

J-113 **Liquid Level Tank Gage.** Form No. 176, 8½" × 11", 2 pages, describes and illustrates non-mechanical distant reading liquid level tank gage which indicates level in inches and quarter inches in any shape of tank at a remote location. Petrometer Corp., 1 Star Square, Long Island City, N. Y.

J-114 **Precision Voltmeter Multipliers.** Bulletin IV-B, 8¼" × 10¾", 2 pages, describes and illustrates Types MFA and MFB sealed resistors for use under severe humidity conditions, such as are encountered in marine service, may be used with one milliampere d.c. instruments and other instruments. International Resistance Co., 401 North Broad St., Philadelphia, Pa.

J-115 **Photoelectric Control Apparatus.** Bulletin, 8½" × 10½", 2 pages, describes and illustrates smoke alarm and combustion control unit Model 133; for ues as indicator and alarm units Model 133 and 134 and the meter unit Model 135 are installed. Oil burner controls are also covered. Electronic Products Co., St. Charles, Illinois.

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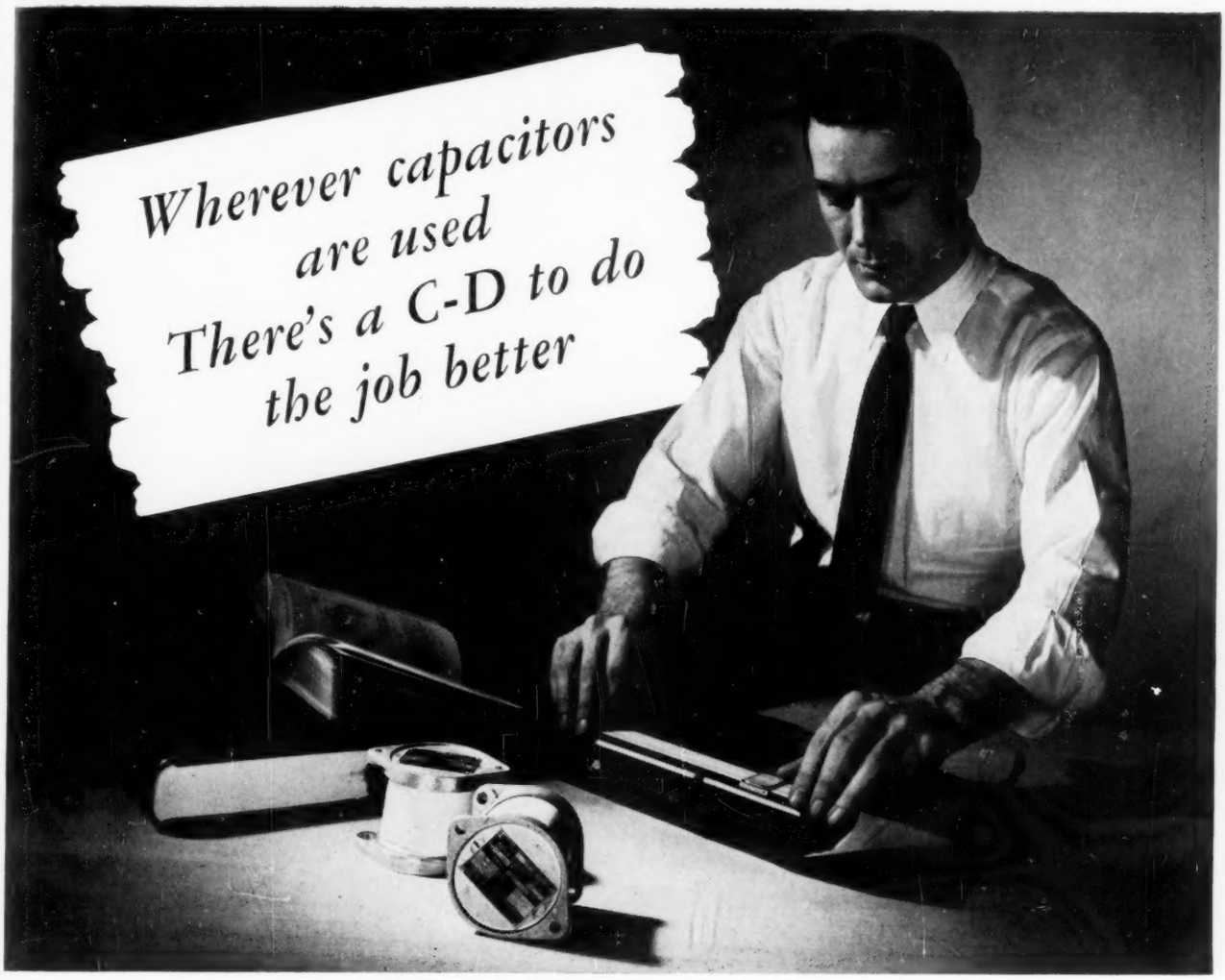

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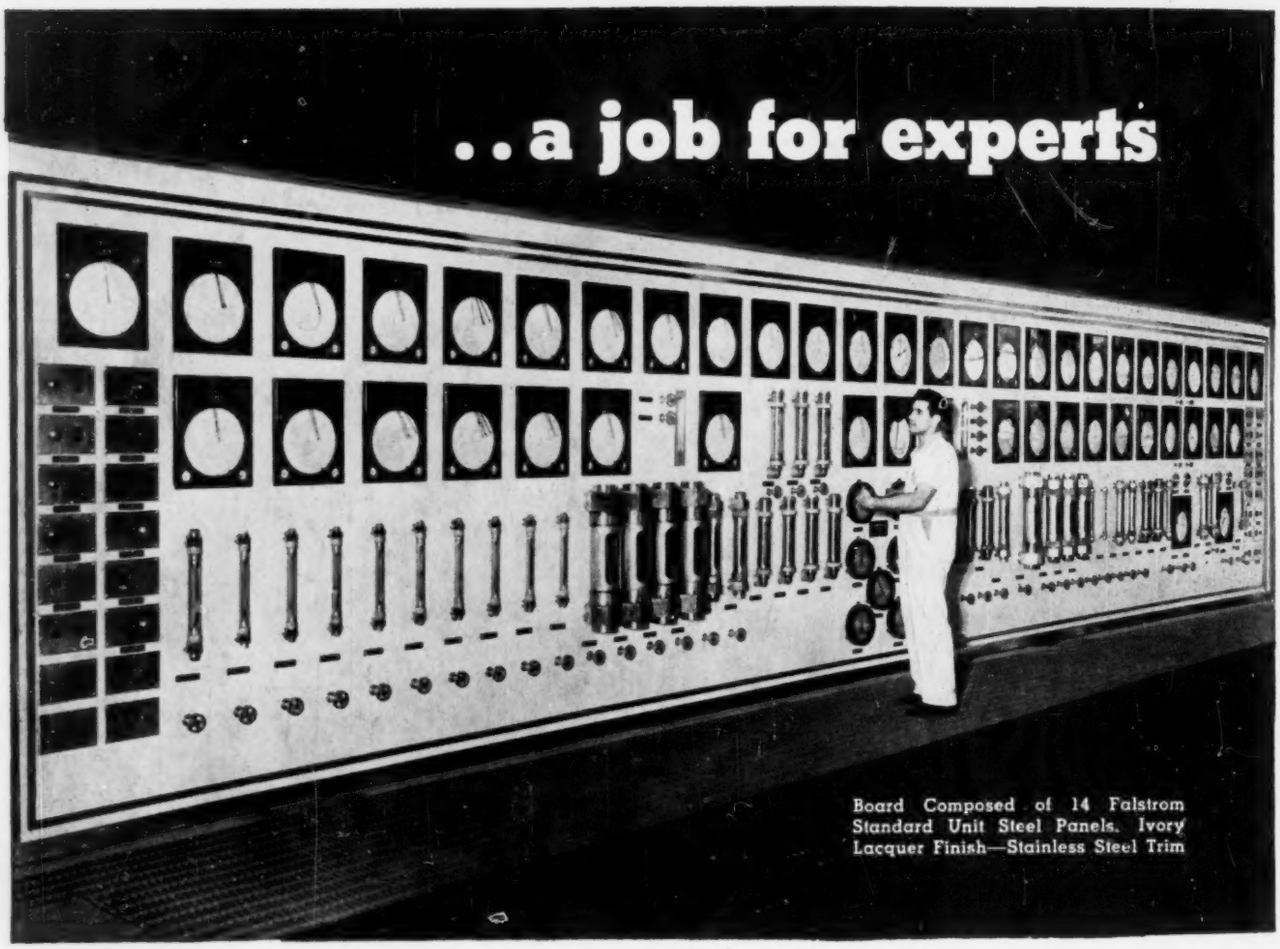

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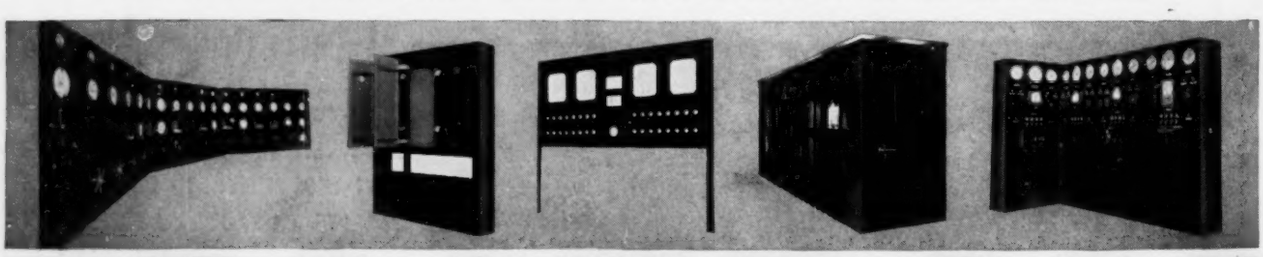

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